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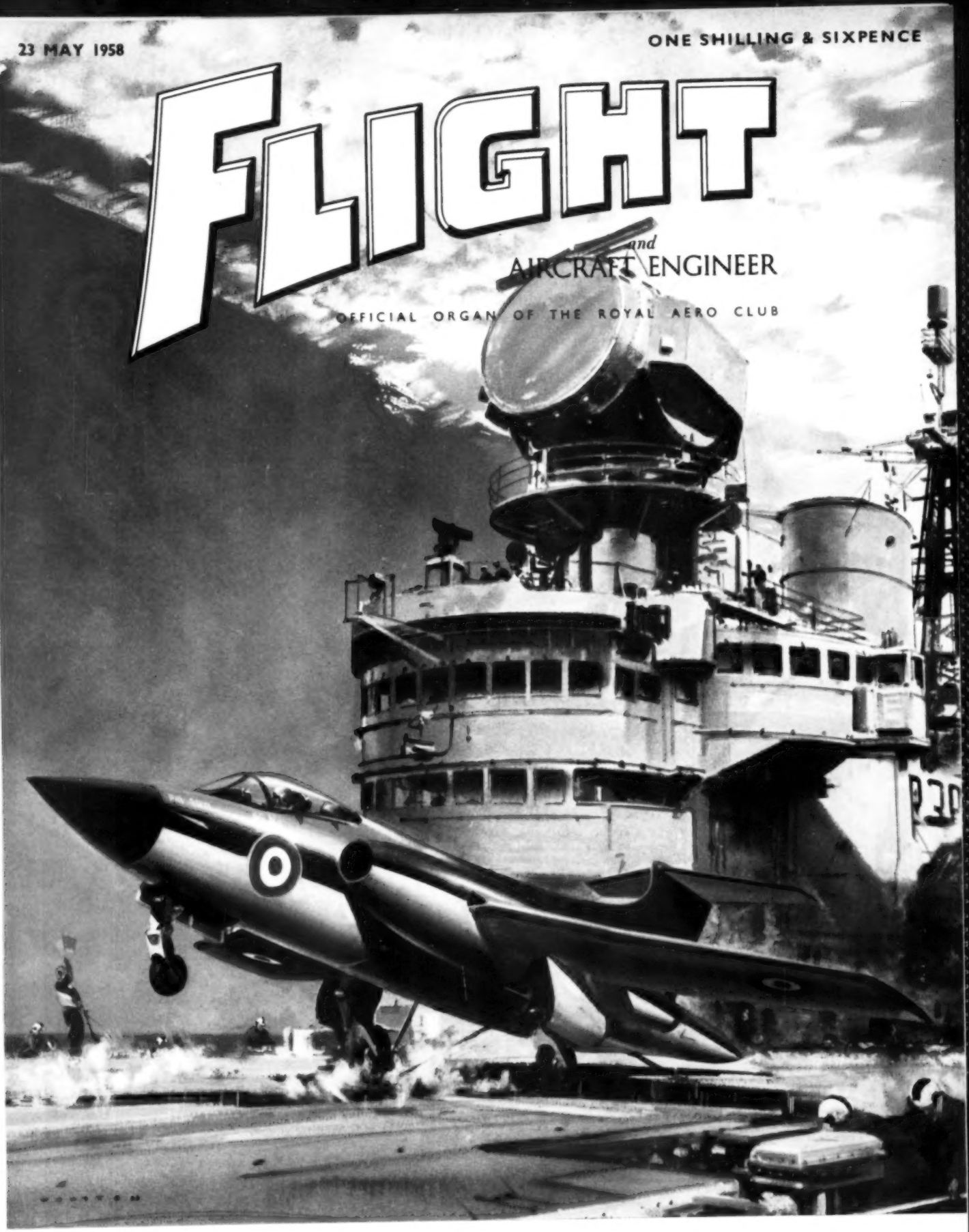

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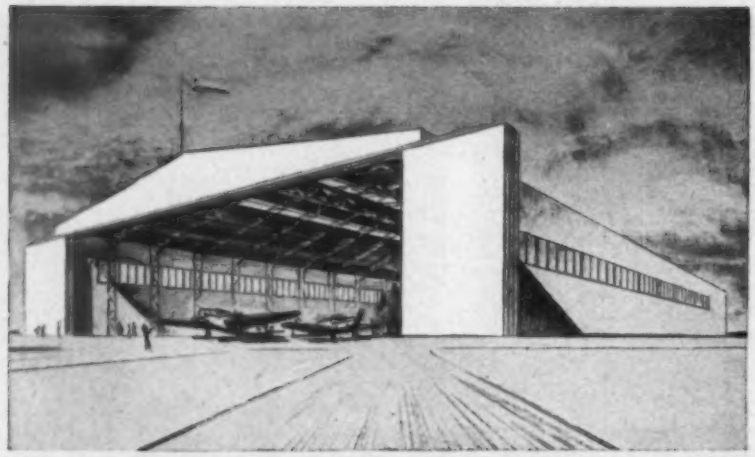

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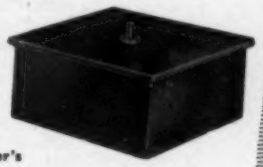

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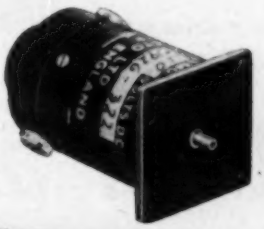

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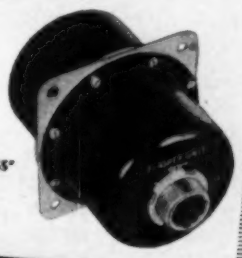

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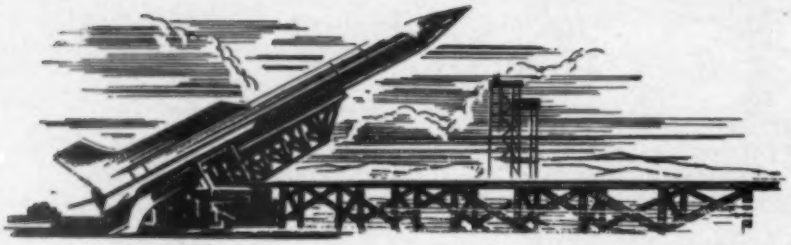

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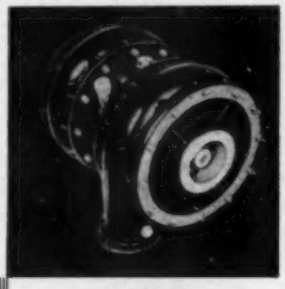

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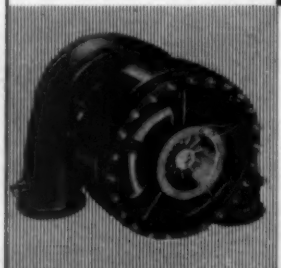

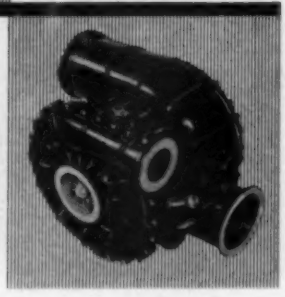

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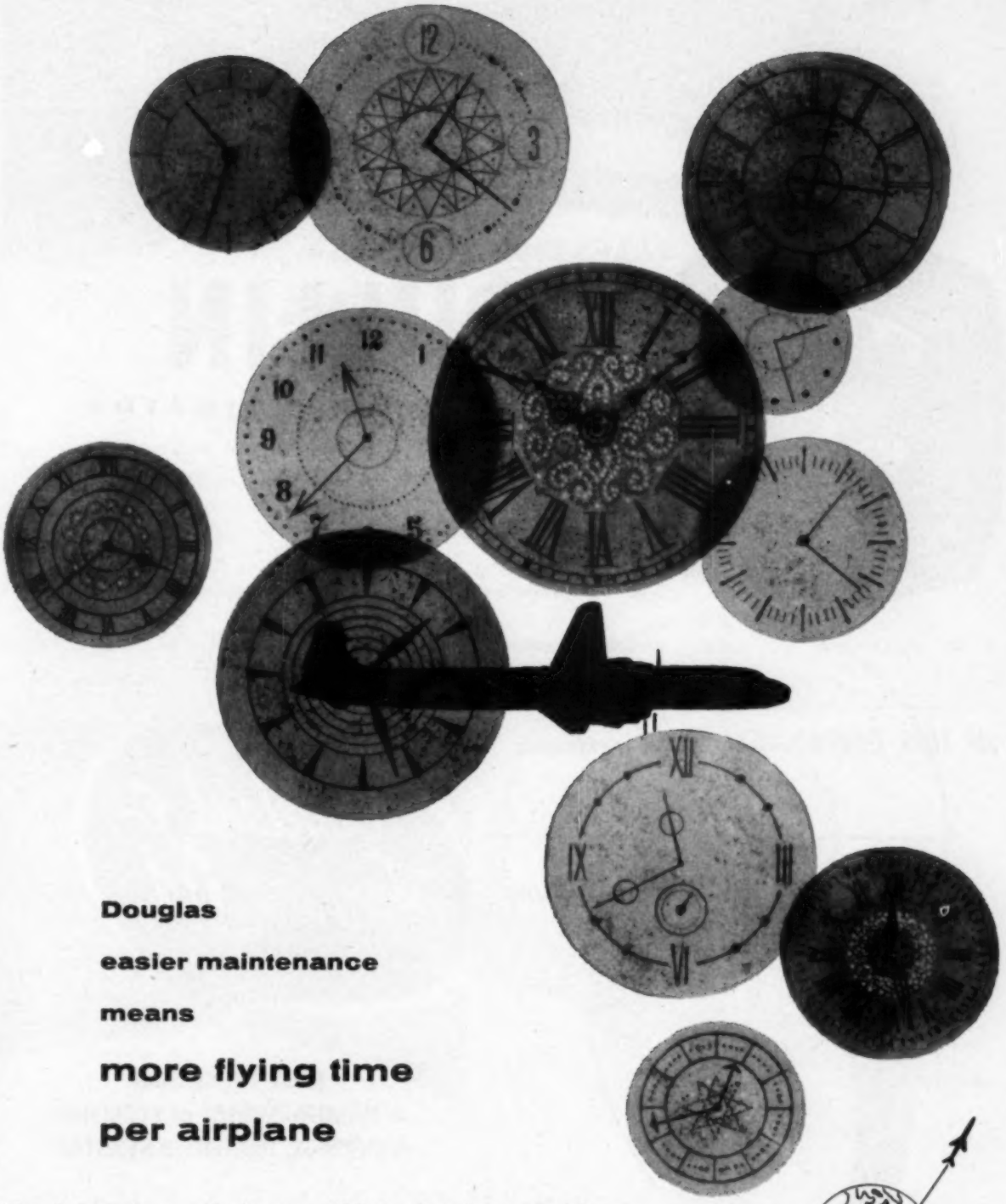

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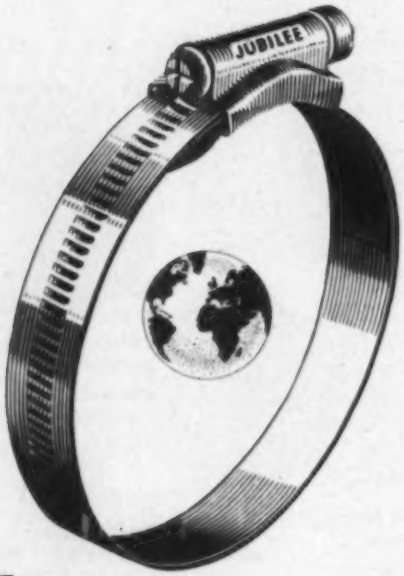

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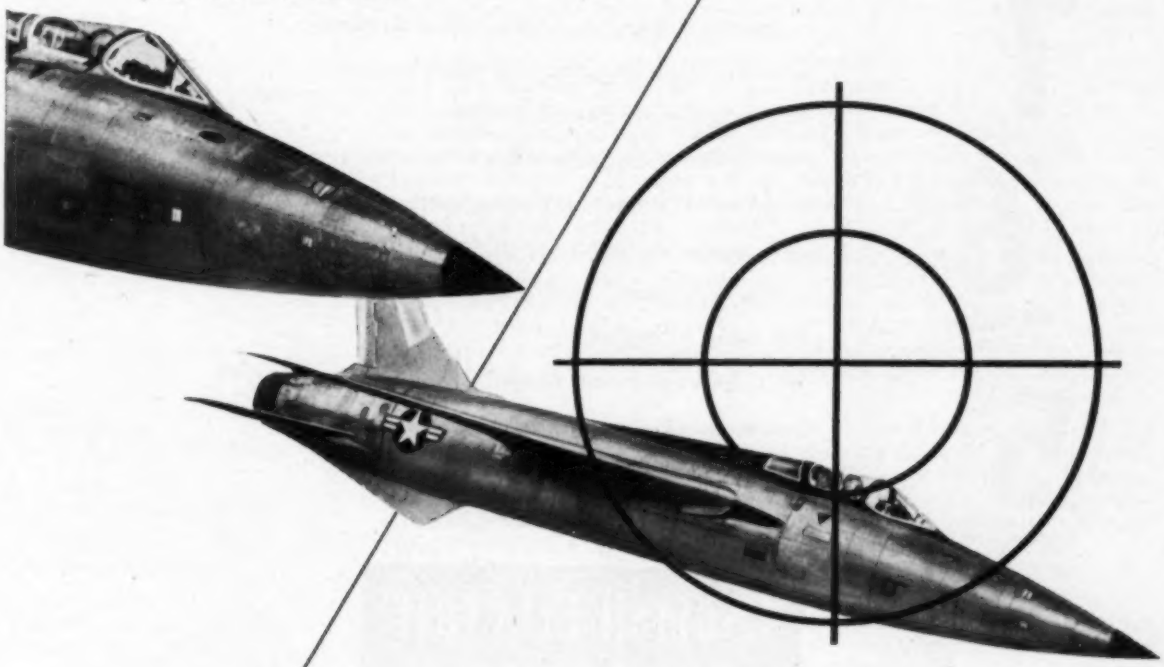

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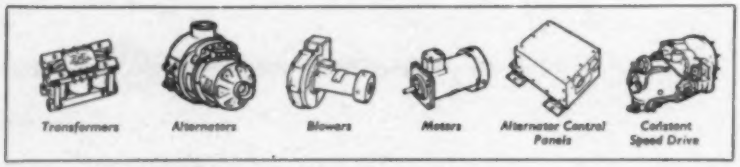

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The Government and the Industry

UPON the Order Paper of the House of Commons for May 13 stood a question which the British aircraft industry has been asking since the Defence White Paper of April 4, 1957. It asked: *Is the Minister of Supply now in a position to make a statement regarding the Government's future policy for research and development in the aircraft industry?*

Mr. Aubrey Jones's answer (see page 694 of this issue) and his subsequent replies to questions from the floor of the House—and from the Press—do not entirely banish the misgivings with which the industry faces the future. No one expected him to propose a magic formula by which the industry could avoid the inescapable contractions of military aircraft work in a nuclear-missile age. The industry must contract; everyone knows this. It is furthermore accepted that the Government should deploy national expenditure in a manner which will foster the formation of stronger industrial units.

But the Minister's statement does little to reassure the industry that the Government feels anything but a short-term responsibility for its civil future. While (encouragingly) the *total* contribution to research—civil and military—will remain on "about the present level," the Government's short-term responsibility will be "a contribution . . . adequate to enable the industry to maintain a leading position." The scale and application and term of this contribution are left vague. And so far as long-term responsibility is concerned, the Government intends to place this "where it belongs, on the industry itself."

These remarks do not suggest that the Government regards the aircraft industry, like nuclear power, as the embodiment of the national technology by which Britain has to earn her living in the world; they are curiously difficult to reconcile with the Minister of Education's efforts to increase Britain's output of technicians and scientists. Nor does it appear that the Government recognizes the extent to which Britain's civil aircraft competitors are fortified by direct and indirect national support.

The industry does not ask that the reasonable private risks of its business should be borne by the taxpayer. It is simply saying that, if Britain is to continue as an exporter of aeronautical equipment to the world's fastest-expanding commercial export market, Government investment in the fount and origin of those exports—civil research and development—must be sustained. This is a business proposition, not an appeal to grandiose ideas of national prestige.

Britain has always lived by her industrial skills and engineering technology. This has never been more apparent than it is today; and the aeronautical industry is one of the nation's prime technological assets. It has proved its ability to sell every kind of aeronautical product against the best which its competitors can offer. It can continue to do so; but airframes, engines and equipment do not flow from "national genius" alone. They are the fruits of *sustained and liberal* research and development. Genius must be financed; and the inspirations and inventions of today cannot become the currency-earning products of tomorrow if the Government leaves them entirely to private capital. So much that may be worthwhile is too costly and too speculative, in competition with other traditional investments, to attract from private sources the capital necessary to see it through.

The Government bears a share of the responsibility for past mistakes and wastages. The pursuit of greatness and the multiplication of industrial resources have not yielded dividends. The industry is prepared to surrender some of its proud and traditional sovereignties in the interests of financial consolidation; the Government for its part must be prepared to continue to invest—with wisdom but without stint—in the civil research and development of that industry.

The Minister said last week: "In the case of the Viscount . . . the Government did quite generously on the investment." Without that investment the development of a rewarding British export would have atrophied.

FROM ALL QUARTERS

Speed Record Claimed

A NEW world air speed record has been claimed by the U.S.A.F. for a flight at 1,404.19 m.p.h. over a measured course on May 16 by a Lockheed F-104A, with Capt. Walter Wayne Irwin as pilot. This took place at Edwards A.F.B., Cal., where the previous record—1,207.6 m.p.h.—was set up by a McDonnell Voodoo last December 12. Both records await ratification.

Short's Pilotless Canberra

MENTION may now be made of the Canberra U.10, a pilotless drone modification of the standard Canberra B.2, prepared by Short Brothers and Harland, Ltd., at Belfast. It is designed to act as a target for missiles at altitudes up to 50,000ft and has made many fully automatic flights, though a check pilot has hitherto been on board. The aircraft's control system has been developed by the research department of Short's. Fireflies and Meteors (the latter converted by Flight Refuelling, Ltd.) have up till now been used for this work.

The Future of Research

LAST week the Minister of Supply, Mr. Aubrey Jones, made his long-awaited statement about future Government policy towards research and development in the industry. Salient points from his brief statement, which was made in the House of Commons on May 13, and from his replies to Members and subsequently to the Press, are summarized below. After acknowledging the importance of the industry's defence-work, the Minister said:—

"The current reduction in defence demands, both in numbers and for certain types of manned combat aircraft, will inevitably entail some contraction in the present size of the British industry, but there will still be a need for an efficient and economic industry to meet the Services' requirements for aircraft and guided weapons. The Government will therefore continue, as necessary, to sponsor and finance aeronautical research and development to meet these defence requirements.

"In addition to its important rôle, the aircraft industry has been making a valuable contribution to the general economy of the country and to technological progress over a wide field of industry. It has been helped materially in this by the research work undertaken under Government auspices primarily for defence purposes. So long as the achievements of the industry justify the expenditure of the public money involved, the Government intend to continue to make a financial contribution to aeronautical research in the expanding field of civil transport, where this is not already covered by the research necessary for defence purposes; such finance will be on a scale adequate to enable the industry to maintain its leading position. The Government have taken this decision in the expectation that in course of time the industry itself will progressively assume financial liability for civil research. In the Government's view, however, it would be fruitless to continue this expenditure unless the industry reorganizes and strengthens itself to the extent necessary to meet the changed conditions with which it is now faced. The future of research depends then on the progress made by the industry itself.

"In the case of civil development the industry has already accepted responsibility for most of the development costs of the new major civil aircraft projects. The Government consider that, provided the necessary reorganization is carried out, the industry should in general be able increasingly to finance the development of new civil projects without government assistance. It is, however, recognized that the development of a future generation of aircraft may require a measure of government help. The Government will, therefore, be prepared to consider individual applications for development assistance on their merits."

In reply to questions from Members, the Minister of Supply made several important points. With regard to the development of a supersonic airliner, he said: "Were [current] research to develop to a point where a design was chosen . . . the Government would consider on its merits . . . the possibility of a government contribution." The scale of the Government's contribution to both civil and military research would continue "on about the present scale." The Minister could not give precise figures, for "to do so would be a breach of security. The two things—civil and military—are inextricably intertwined. . . . As civil research becomes more and more identifiable, then the cost of that research will be passed in course of time on to the industry itself."

On the subject of the supersonic airliner project developed by Dr. Barnes Wallis of Vickers (which has been dubbed Swallow) the Minister said: "I understand that the Americans . . . are considering the possibility of giving some financial aid for such a project, but there is no decision."

In answer to questions at a Press conference, Mr. Aubrey Jones said that he foresaw a contraction in the size of the industry over the next five years amounting to about 100,000 people from the present level of about 250,000. He questioned whether there was much room for more than about two aero-engine units and three or four airframe units. He compared this with two major aero-engine units in the U.S.A. and four or five major airframe units. [In fact, the U.S. industry has at least ten aero-engine units having work-forces of not less than 5,000 men, and 14 airframe constructors having work-forces of not less than 10,000.—Ed.]

Questioned about possible Government assistance to the industry's airliner export-financing problems (see last week's *Flight*), the Minister said that while his department was studying this matter, he did not see what help the Government could give in this context, and that it was "up to individual firms to strengthen themselves financially."

New Handley Page Directors

FROM Handley Page, Ltd., comes the announcement that Sir Arthur Vere Harvey, C.B.E., M.P., having accepted the chairmanship of the CIBA Companies in Great Britain, has resigned from the Boards of Handley Page and its subsidiary, Handley Page (Reading); and that, owing to pressure of other business, Sir Thomas S. Overy has likewise resigned his directorship.

Mr. R. S. Stafford.

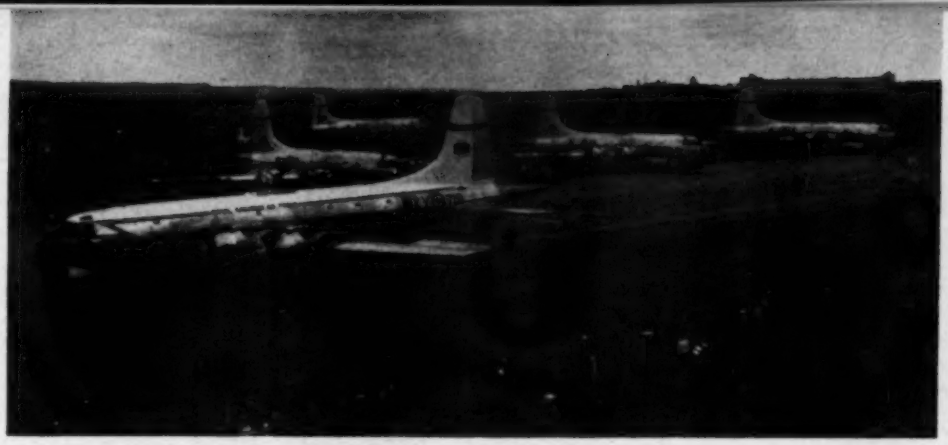
G/C. R. C. M. Collard.

Mr. R. S. Stafford, C.B.E., F.R.Ae.S., director of the H.P. technical department, and G/C. R. C. M. Collard, D.S.O., D.F.C., sales manager, have been appointed directors of both the H.P. companies. Mr. E. Manley Walker, a director and the manager of Handley Page (Reading), is now a director of the parent firm.

Postscript on "Prospect"

BOTH the Prime Minister and the Secretary of State for Air were questioned in the Commons last week about the R.A.F. conference Prospect Two. Mr. Macmillan said that there were many reputable precedents for holding such a conference, and he

VIGILANTE: This is the name given to the U.S. Navy's A3J-1 supersonic bomber developed by North American's Columbus division. Powered by two afterburning G.E. J79s the first was completed on May 15.



***IN SERVICE:** Last Saturday, May 17, a ceremony was held at R.C.A.F. Greenwood, N.S., to mark the handing over of the first group of Canadair CL-28 Argus anti-submarine aircraft to the Maritime Air Command. They are replacing the Neptunes of 405 Sqn. which in turn will displace Lancasters at Comox, B.C.*

was assured that nothing had been said which conflicted with the Government's declared defence policy. The remarks of the Assistant C.A.S. [about more manned aircraft] related to a situation "which might or would arise if a defence were found against the ballistic missile."

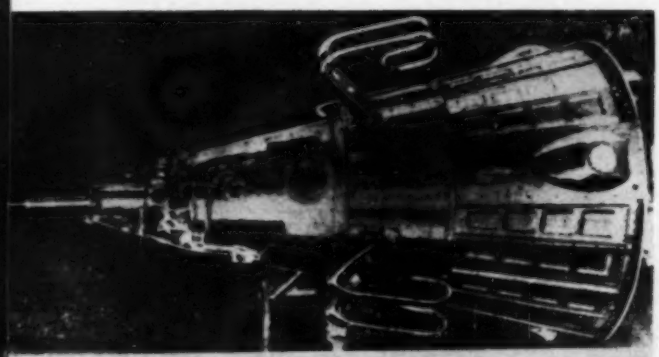
Mr. George Ward, the Air Minister, said that the conference had been held "with the authority of the Minister of Defence and myself." He reiterated that it did not indicate any divergence from Government policy, adding that there was no divergence of opinion between the Minister of Defence and himself and that the C.A.S. and his colleagues were "absolutely loyal supporters of Government policy."

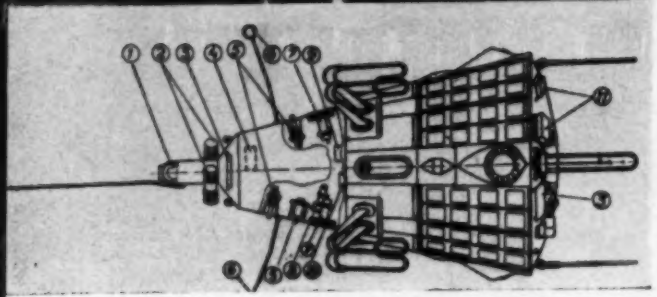
1¼-Ton Sputnik

WEIGHING no less than 2,920 lb, the Soviet Union's third artificial Earth satellite was launched into a 65-degree, 106-minute orbit on Thursday, May 15. Conical in shape, the satellite measures 11ft 8in high and 5ft 8in base diameter and was reported to have an initial apogee of 1,170 miles. Also in orbit is the sputnik's carrier rocket.

The weight of instruments, radio equipment and batteries was reported to be 2,140 lb. The instruments are capable of studying the pressure and composition of the atmosphere; the concentration of positive ions; the electric charge on the satellite and the Earth's electrostatic field; the intensity of the Earth's magnetic field; the sun's corpuscular radiation; the composition and variation of primary cosmic radiation and the distribution of photons and heavy nuclei in cosmic rays; micrometeors; and the external and internal temperatures of the satellite.

A special feature of the satellite is its thermal regulating system, which changes the co-efficients of radiation and reflection on its surface to effect an almost-constant internal temperature. A multi-channel telemetering system is included, and the radio transmitter, which emits continuous signals of 20.005 Mc/s, is powered by both electro-chemical and solar batteries. The telemetering system is said to be controlled by a programming device.





200-year Satellite

THE considered estimate that the U.S. Navy's Vanguard test sphere (the grapefruit-sized satellite) now in orbit would have a life of 200 years was quoted in London on May 12 by a scientist of the U.S. Office of Naval Research. The speaker was Dr. George C. Sponsler, science liaison officer attached to the London branch of O.N.R., who was presenting a paper on the Vanguard satellite programme at the Production Exhibition.

Dr. Sponsler said that the series of Vanguard test firings had been completed, and that the U.S. Navy hoped to follow these with the launching into orbit of six fully instrumented spheres. The success of the solar batteries (silicon semiconductor devices) in powering one of the transmitters of the small test sphere, he suggested, might prove embarrassing, in that a very long occupation of 108.03 Mc/s might interfere with other work.

Joining the Woodford Pilots

NOW with the Avro test pilots at Woodford is O. J. Hawkins, a New Zealander, who was previously doing Javelin development flying for Gloster Aircraft. He joined the R.N.Z.A.F. in 1942, flying P-40s and Corsairs in the Pacific theatre. In 1951 he transferred to the R.A.F., serving in night-fighter squadrons, and thence to R.A.E. Farnborough, the E.T.P.S., and Boscombe Down.

Mr. O. J. Hawkins.

U.S.A.F. Open Day

U.S. Armed Forces' Day was commemorated by the U.S.A.F. in this country with "open days" at nine bases, seven of which held flying and static displays of U.S.A.F. and R.A.F. aircraft. Both the Skyblazers' F-100s and the Hunters of No. 111 Sqn. did formation aerobatics at Alconbury (Hunts), while the Skyblazers also appeared at Bentwaters (Suffolk) and No. 111 Sqn. at Sculthorpe (Norfolk). One of the other bases open was Burtonwood, from which a correspondent has sent us the following report:—

A radical change in logistic concepts has spelled the end of Burtonwood as headquarters of the Northern Air Materiel Area, Europe, which ceases to exist on June 30; and with the adoption of a "direct supply" system from the U.S., it is ceasing to be the Q.M.'s store for U.S.A.F. units in Northern Europe.

Last Saturday's display, which over 80,000 people attended, seemed symptomatic of the base's run-down (its personnel is being reduced this year by 1,000 to 3,500); for there were fewer aircraft on show than in 1957, and flying was limited to a "beat-up" by a formation of F-84Fs and low passes along the runway after take-off by aircraft which had been on static show—an F-100F (asymmetrically tanked and using reheat), F-84F and B-66B. Among other types on view were the Globemaster, F-86D, Sabre, WB-50D Superfortress, B-45A and (from the R.A.F.) a Canberra, Hunter, Javelin, Vampire T.11 and Provost.

***SPUTNIK III:** These official Russian illustrations show the third satellite fired by the Soviet Union, placed in orbit on May 15. The device is 11ft 8in high and 5ft 8in diameter at the base, and weighs approximately 2,900 lb. Details are:—*

1, Magnetometer measuring gravity; 2, photo-multiplier for solar corpuscular radiation; 3, solar batteries; 4, cosmic-ray photon counter; 5, manometer sensitive to magnetic field; 6, ion traps; 7, "fluxometer" sensitive to electrostatic potential; 8, mass spectrometer; 9, unit sensitive to heavy nuclear particles in cosmic rays; 10, unit for measuring the intensity of primary cosmic rays; 11, micrometeor counter. The hook-like tubes are aerials.

FIAT G.91

First-generation NATO Strike Fighter

Fiat G.91 fixed armament of four 0.5in machine guns and ammunition tanks is mounted on the hinged panels, as shown. External loads for each wing, in addition to the fuel tank shown at left, include 5in HVARs, honeycomb packs of 30 folding-finned unguided rockets, and six 3in rockets. It is also reported that Nord 5103 command-guided rockets can be fitted for ground attack.

THE French, German and Italian governments have now definitely chosen the G.91 as the standard LWSF (lightweight strike fighter) for NATO service "until 1961." It appears that this decision was reached on the condition that, after 1961, a French aircraft—almost certainly a developed Bréguet Taon—would replace the G.91.

The "mission profile" required of the LWSF in the original NATO specification is now well known. This and the associated operating requirements called for a simple, robust aircraft which could be easily serviced with the minimum of ground equipment, provide the greatest fire-power and operate from unprepared fields. A manned aircraft was needed to provide the flexibility in attacking targets of opportunity, with which a missile could not deal. NATO is still convinced that machine-guns constitute the most effective weapon against "soft-skinned" targets. The risk to the pilot is considered relatively low, because the fast low-level approach affords an excellent opportunity of surprise.

The G.91 fills the requirements well, for, with the leading-edge slats of the G.91A version, it can take off or land on about 600 yd of grass, and its fire-power is equivalent to that of a large fighter. Its manœuvrability allows it to operate in mountainous country, to position itself rapidly to attack a chance target and to escape from ground fire by climbing rapidly out of range. Great care has been taken to make the G.91 easy to maintain, for operation from advanced bases. As the type will be used by several air forces, it will be able to operate with almost any NATO command.

Principal dimensions of the G.91 are: span, 27ft 11in; length, 34ft 2in; height, 13ft 1in; wing area, 177.5 sq ft; and sweep at 25 per cent chord, 37 deg. Horizontal tail-surface area is 26.8 sq ft. The Bristol Orpheus 3 confers on the G.91 a thrust/wing-area ratio of 26.6 lb/sq ft. At a gross weight of about 11,000 lb, which includes external stores, thrust/weight ratio is 2.35. With machine-guns and ammunition, but no external stores, the ratio is 2. Equipment and internal arrangement were laid down in close collaboration with the AGARD committee. Both cockpit and tank bays are protected by steel and the nine tanks are close to the c.g.

Replacement of major components such as wings and engine can be carried out by very small teams of men working in the field. Aileron and elevator control is by irreversible hydraulic jacks with spring feel and manual reversion, while the rudder is "manual" and carries a yaw-stabilizer. Cockpit equipment includes pressurization, electronic temperature control, ventilation, oxygen, windscreen de-icing, anti-g suit and a Martin-Baker lightweight, fully automatic seat. Cockpit dimensions have not been specially restricted. Engine-starting takes 40 sec and the hydraulic, powered wheel-brakes are used for steering.

On take-off, rudder becomes effective at 50 kt, 40 deg of flap may be used, and stability is positive in all three axes immediately after unsticking at about 100 kt. Initial acceleration on take-off with full external load is over 0.4 g; and accelerations of this order can be obtained in the air. At 5,000ft, level speed can be increased from 280 to 400 kt in 30 sec; and 460 kt are exceeded in less than a minute. The G.91 can reach 377 kt 90 sec after "brakes off."

Both static and dynamic stability in all three axes and at various trimmed speeds remain positive. The stall comes at about 110 kt, heralded by buffeting at over 130 kt. Little height is lost. The G.91 may be trimmed "hands-off" at speeds below 1.3 Vsl.

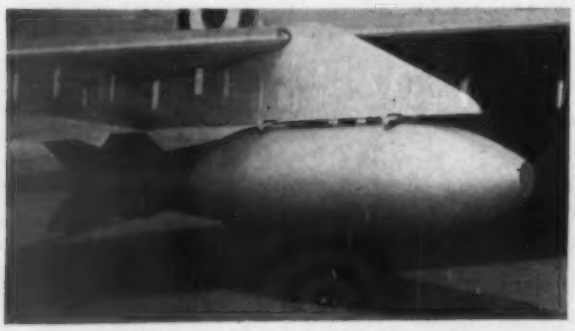
Maximum sea-level I.A.S. is about 580 kt and 0.91 Mach can be reached at 20,000ft. At 30,000ft Mach 1 is easily exceeded in a shallow dive. The yaw damper in the rudder circuit makes the G.91 a particularly good platform for both guns and bombs.

Four-g pull-ups are regularly performed at Mach numbers between 0.96 and 0.98. Extension of the airbrakes, taking 4 sec, produces a positive acceleration of 0.4g at 350 kt; and nose-down trim when retracting them can be held with a stick-force of 4½ to 6½ lb. Bombs may be dropped with airbrakes extended.

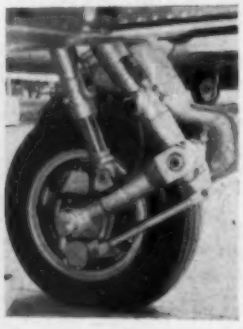
At cruising speed the G.91 can achieve a rate of roll of 250 deg/sec, while at 150 kt 100 deg/sec are still available. Only slight adverse yaw results from rolling. The low wing is sensitive to ground effect, considerably assisting landing. The above figures refer to fully loaded G.91s carrying two 500 lb bombs.

Some 20 per cent of the gross take-off weight of the G.91 consists of weapons; and 50 per cent of this gross weight is accounted for by fuel and armament combined. The range of weapons includes 0.5in, 20 mm or 30 mm guns, tactical nuclear weapons, air-to-ground rockets and missiles. The G.91 can remain airborne for one hour at sea level and, operating from fields close to the front, can spend most of that time ranging over enemy territory. The aircraft can also be rapidly converted to carry a full range of still and motion cameras for oblique or vertical photography at all altitudes.

Single hydraulic jacks operate each undercarriage leg while a fourth jack operates a cable linkage serving the main leg up-locks and fairing-door latches. All three legs are locked down by bolts operated by main hydraulic pressure. In emergency, the nose-wheel is lowered by pressure tapped direct from the accumulator, while the mainwheels drop under gravity after doors and locks have been unfastened. The nosewheel rotates during retraction to lie flat in the fuselage. Emergency braking power is also available. The flaps are extended by screw-jacks operated from a common flexible-shaft system by an electrical actuator. Nine tanks are included in the fuel system, transfer being by air pressure and balancing by fuel flow-proportioner.



(Left) a 500 kg bomb on the starboard pylon. Note how the pylon is "wrapped" round the leading edge.



(Right) the Messier levered main-wheel suspension, hydraulic disc brake and Kléber Colombes low-pressure tyre.

Defense

PART 3: TO AIRCRAFT PLANTS AND S.A.C.

By a Special Correspondent

"Designed to serve equally well as a fighter/bomber, an air-superiority fighter or a trainer"—the North American F-100F.

OUR faithful Convair (coping bravely with the additional weight of masses of literature and pamphlets we had already collected) took us comfortably from El Paso to Los Angeles across New Mexico and California. After the brilliance of the desert it was disappointing to have to await our turn for a G.C.A. landing—above thick cloud, which the Californians protested was unusual. But it was an object lesson in traffic control, watching other aircraft in the stack disappear into the cloud below us as their turn for landing came.

We pulled up in neat MATS style on the industrial side of the airport, to be welcomed by a bevy of executives of North American Aviation who wanted to show us the production line of the two-seat F-100F.

Before we were taken into the gleaming F-100 shed we had the inevitable briefing. This time North American pulled out all the stops to tell us that, if the Government would find the money, then space flight and satellites were only just around the next cloud. All very stimulating and a striking lesson in original thinking to our own industry.

The F-100F line is impressive. This aircraft North American describe as a "triple-threat airplane" designed to serve equally well as a fighter/bomber, an air-superiority fighter or a trainer. Major Robinson Risner, the man who a year ago flew non-stop across the Atlantic in 6 hr 37 min, was there to tell us about the aircraft which first made the U.S.A.F. supersonic. Then followed a talk about the X-15, to be flown in a year's time. Wind-tunnel tests are nearly finished and Reaction Motors are getting on well with the liquid-fuel rocket engine. Now North American have started to cut metal for the airframe at the Los Angeles plant,

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THIS is the third dispatch from a correspondent who is a member of the party to which the U.S. Armed Services have given special facilities for inspecting their newest equipment and methods. His previous articles appeared in our issues of May 2 and May 16.

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and modification of the B-52 which will launch the X-15 is also well advanced.

Next day to Douglas, to plod around the DC-8 production line in the shiny new plant at Long Beach and to watch the pre-flight checks of the first "8" to roll out. It has so far cost Douglas some $200,000,000 in payrolls, engineering facilities, tooling and material. Ground testing of the aircraft will very soon be finished, and the flight-test programme will then begin. The company intends to use at least nine production aircraft during C.A.A. certification.

From Long Beach to Santa Monica, where Elmer Wheaton, Douglas' chief missile engineer, introduced us to the SM-75 Thor. He thinks that co-operation between U.K. and U.S. missile engineers is going along well. We learned that the Thor could be fired from underground pads, but that in the controversy over "soft" and "hard" sites the former had so far won because of the urgency and their cheapness—or, rather, relative cheapness.

Then back to the Convair for the long flight from Los Angeles to Offutt A.F.B., Omaha, Nebraska—via the Grand Canyon, of course, to show us that fantastic jagged slash in the earth's surface. There were none of the usual jet-streams about, so the Convair gave us something like a seven-hour flight. Only four weeks before, the same crew and the same aircraft had gone all the way from Los Angeles to Washington in only 8¼ hours.

At Offutt, headquarters of mighty S.A.C., the first aircraft we passed on the hard standing was a Canberra staging through from Christmas Island. Transport Command Comets on the regular run to Christmas or even Woomera call at Offutt frequently.

General Tom Power was travelling about America and could not greet us. But the vice-chief of S.A.C., Lt-Gen. "Butch" Griswold—known to many people in England when he was commander at South Ruislip—was a fine host. Interviewed, he denied that any S.A.C. aircraft had ever taken off "prepared to launch an atomic weapon." And he made it clear that B-47s or B-52s already in the air when the Dew-Line had reported odd plots had never been sent over the Pole.

He expounded a philosophy which I found current among all American's armed forces: that the "mission" is to keep a war from *starting*, and that if there ever is a war then everybody will have failed in that mission. The day of the manned delivery system will never be over, he told me. Missiles are all very well, but once the button is pressed you can't bring them back. "There's no provision in any missile for it to change its mind," he said; "as far as the manned bomber is concerned, 'fail safe' is a guaranteed method of getting them back."

He gave us some S.A.C. facts and figures. The Command is starting a big dispersal programme, with a base looking after two or three satellite airfields so that, in the end, the deterrent capabilities of the Command will be maintained. At present there are 28 medium bombardment wings of B-47s, eleven heavy bomber wings—the three remaining B-36 wings are soon to be converted to B-52s, which make up the other eight—and five recce wings. KC-135 tankers are progressively replacing the elderly KC-97.

The B-58 Hustler will soon be in service. What S.A.C. likes is its dash capability—1,400 to 1,500 miles an hour. And the new jet tanker, the KC-135, can reach an altitude and speed compatible with the bombers it has to feed. There are big hopes for the latest American air-to-surface missile (what we call the stand-off bomb), the Hound Dog. The earlier Rascal missile is already in service with B-47 wings.

The B-52G will carry two Hound Dogs, one under each wing, to be released 300-350 miles away from their target(s). The bomber will also carry a bomb, so that it can press on to yet another target.

The B-70, however, is obviously the apple of the official S.A.C. eye. But it is as yet only a glint—a glint about which we were allowed to know very little.

A staff officer told me something about S.A.C. personnel. To get a picture of the typical S.A.C. aircraft commander, 745 officers were quizzed. Average age, it was discovered, was just over 35 years. Each had over 4,000 hours of flying and more than 12 years in commissioned rank. Average time of command of an aircraft was 21 months, and 61 per cent had actual combat experience; they had flown an average of 42 combat missions. It was interesting, too, to note their ranks. There were 96 colonels, 306 majors, 338 captains—and only five lieutenants. It was discovered that 85 per cent were married, and that each had at least one child.

S.A.C.'s accident rate is coming down. In 1950 it was 43 for every 100,000 hours flown—when the annual total of flying hours was some 400,000. Last year, when 1,250,000 hours were flown, the rate was down to 5 per 100,000 hours. That includes every little scrape and dent to an aircraft on the ground as well as accidents in the air and on landing and taking off.

Basic concept for the use of this massive deterrent force is that each aircraft would strike from its base. That is because Russia is capable of launching a surprise attack. But in the event of a sufficiently long warning period, it might be possible to move some squadrons nearer their targets. To meet this possibility, a complete fly-away kit of spares is held by all squadrons, to allow them 30 days' operation while cut off from all supplies.

The "alert" concept of S.A.C.—explained many times but still confused in the minds of numerous people—is simple. It is based on the need for at least one-third of the force to be airborne in fifteen minutes from the time of a genuine alert. At the moment that proportion has not quite been achieved. It is likely that

(Concluded on page 708)

DISTINGUISHED GATHERING: Before Dr. G. W. H. Gardner delivered the Wilbur Wright Memorial Lecture of May 15 the Royal Aeronautical Society's awards and medals were presented by the new president, Sir Arnold Hall (right). Recipients were (in pairs, from the top): Sir Richard Southwell (Hon. Fellow) and Mr. W. E. Nixon of de Havilland (Hon. Companion); Sir Sydney Camm, Hawker Aircraft (Gold Medal) and Dr. P. B. Walker, R.A.E. (Silver Medal); Dr. D. Williams, R.A.E. (Bronze Medal), and Mr. S. D. Davies, Dowty Fuel Systems (British Gold Medal for Aeronautics); Messrs. W. H. Lindsey and W. F. Saxton, both of Armstrong Siddeley (British Silver Medals); Mr. W. Tye, Air Registration Board (Wakefield Gold Medal) and Mrs. Anne Burns, R.A.E. (R. P. Alston Medal). Unable to be present to receive the N. E. Rowe Medal was Mr. P. A. Champion of Bristol Aircraft.

"Flight" photographs at the meeting.

HERE AND THERE

Franco-German VTOL

FOLLOWING an agreement signed between SNECMA and the West German Defence Ministry on the joint development of VTOL aircraft, it is announced that the first Franco-German coleopter will be test-flown early next autumn.

Johnston Trophy Award

S/L. JOHN H. LEWIS, leader of the R.A.F. detachment with the Commonwealth Transantarctic Expedition and pilot of the Otter which on January 6 flew over the South Pole from South Ice to Scott Base, is to be awarded the Johnston Memorial Trophy for air navigation by the Guild of Air Pilots and Air Navigators. It will be presented to him on May 28.

ASW Electra

ON May 2 we reported that the U.S. Navy had placed an order with the California division of Lockheed Aircraft for 80 Electras converted for anti-submarine warfare rôles. These aircraft, which will probably be designated P3V, will replace the P2V Neptune. It is now stated that a contract for £714,000 has been placed for the engineering R. and D. to convert the aircraft to its new rôle. An aerodynamic prototype will be flying in August. It is also learned that the runner-up for the award was a DC-7 variant with Rolls-Royce Tynes.

Chester Display

ON Saturday, May 31, at 2.30 p.m., the Chester Branch of the R.Ae.S. is holding an aeronautical show and garden party at Broughton, near Chester. There will be flying and static displays, and some veteran aircraft. Attendance will be "restricted."

Advisory Invitation

MR. E. D. KEEN, chief designer of Sir W. G. Armstrong Whitworth Aircraft, Ltd., has been invited by the council of the Royal Aeronautical Society to represent that body on the new advisory committee on aeronautical engineering at Loughborough College of Technology.

Malton Appointment

APPOINTMENT of Mr. J. L. Plant as president and general manager is announced by Avro Aircraft, Ltd., Canada. Formerly executive vice-president and general manager, he has had wide experience in aviation, both as a pilot and in administrative posts with the R.C.A.F.

S.M.A.E. Championships

ABOUT a thousand competitors are taking part in this year's National Model Aircraft Championships, which are being held at R.A.F. Waterbeach on Sunday and Monday (May 25 and 26). Flying will begin at 9.30 a.m. on both days, and the prizes are to be presented on the Monday evening, instead of—as in former years—at the S.M.A.E. annual dinner.

Student Prince

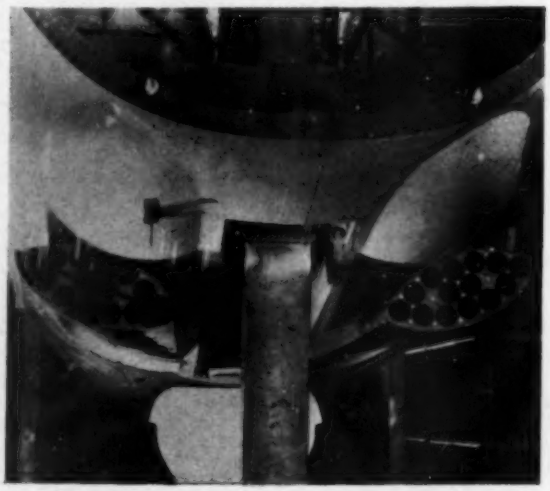
APPOINTED chief test pilot of F. G. Miles, Ltd., Duncan McIntosh has been test-flying for the company on a part-time basis since 1955 and demonstrated the Student at Farnborough last year. With Airwork, Ltd., until his new appointment, Mr. McIntosh flew in Fighter Command during the war and until 1955 was a member of No. 603 (City of Edinburgh) Sqn., R.Aux.A.F.

Fly-it-yourself

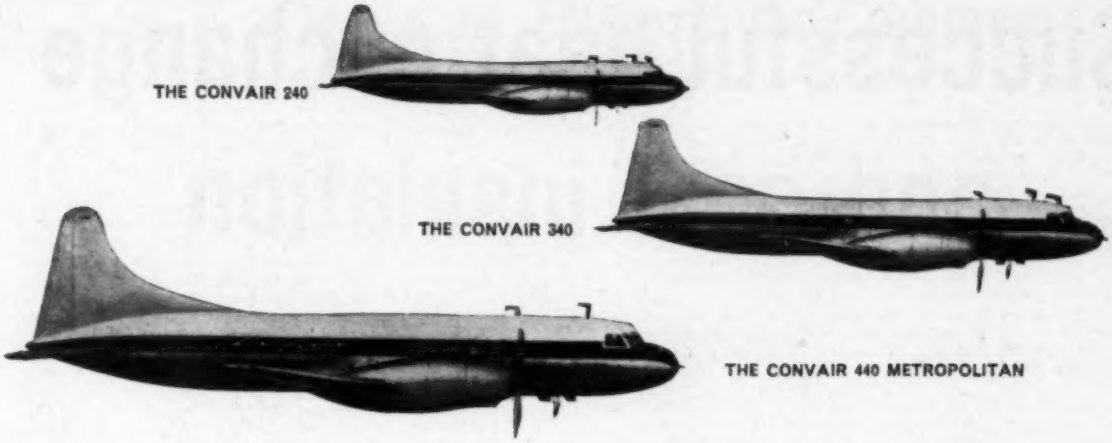
FROM May 26 a "rent-a-plane" service is being inaugurated in 56 U.S. cities by Hertz Rent A Plane System, Inc., a new wholly owned subsidiary of the Hertz Corporation. Aircraft will be rented to individuals or groups either on a "taxi-plane" (charter) basis with pilot provided, or to qualified pilots on a fly-it-yourself basis.

W.R.A.F. Officers' Reunion

ON Saturday, June 7, the W.R.A.F. Officers' Association is holding its third reunion, at the Victory Club, 73 Seymour Street, London, W.2. Tickets (members only) are 8s 6d, and all former W.R.A.F./W.A.A.F. officers and serving W.R.A.F. officers who would like to join and have not yet applied for a ticket should write to the Hon. Secretary, Rm. 437, Air Ministry, Adastral House, London, W.C.1.



NEW FANGS: It is now permissible to disclose that the de Havilland Sea Vixen FAW.20 all-weather Naval intercepter carries secondary armament of 28 two-inch spin stabilized rockets, in these retractable packages under the cockpit. Made by Microcell, Ltd., in glass-fibre reinforced plastic, the rocket batteries extend, fire and retract automatically. The Sea Vixen's four underwing pylons can each take a Firestreak air-to-air guided weapon or a further pack of 24 rockets.



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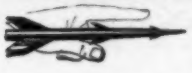

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S. F. Cody: an Historian's Comments

By CHARLES H. GIBBS-SMITH, M.A.(Harvard), F.R.S.A., F.M.A., Comp.R.Ae.S.

IN these comments on Mr. G. A. Broomfield's personal reminiscences of S. F. Cody, published in "Flight" last week, Mr. Gibbs-Smith—an eminent authority on aeronautical history—adduces evidence on the pioneer's 1908 experiments from "The Times" and other contemporary sources. While gladly granting him space in which (as he says) "to get the record straight," we feel that readers, whatever views they may hold or form, will have recognized and enjoyed, as we did, the intensely personal and nostalgic vein of the original article.

AS one of those involved in investigating the history of the Cody tests of 1908 I feel, reluctantly, that I should put forward certain facts which I am afraid contradict most of what Mr. G. A. Broomfield says about the year 1908 in his article in last week's *Flight* ("S. F. Cody—a Personal Reminiscence").

First, a small historical point: it was Esnault-Pelterie who first used ailerons (in 1904), not Cody. Then we come straight to the main question of when and how Cody made his first powered and sustained flights. Mr. Broomfield states that it was on May 16, 1908, when Cody made five tests and left the ground for 150ft in his longest "flight"; that these tests were officially witnessed; that Cody "was very excited at his success"; that he had detached his ailerons before the tests and used wing-warping for the tests; that "*The Times* was the only paper to notice the daily events in May"; that Cody described these tests in his lecture to the Aeronautical Society in December 1908; that he attempted another flight at the end of May; made yet another attempt soon after that; flew 78 yd in September; and made a flight of 496 yd on October 5, which ended in a crash, after which he did not fly until early 1909.

I can only conclude that Mr. Broomfield has unwittingly telescoped in his mind those dramatic events of long ago. First of all, there is no known contemporary account of the May 16 tests. There is no official account, and no press account, and *The Times* —despite your correspondent's assertion—does not refer to any tests at all during May or June, not even "rolling tests"; nor is there any contemporary account to be found anywhere of any other tests in May or June.

The other points are best dealt with by describing what we do know happened later. (Space does not permit quotation of more than a few words here and there from the excellent and detailed coverage provided by the contemporary sources.) The first test of which we have any contemporary record was on September 19, 1908 (see *Daily Chronicle*, September 22) when it was announced: "War Office aeroplane—Secret trial said to have given satisfactory result . . . the machine . . . did not rise from the ground. . . . On inquiring at the factory last evening the information was elicited that the trial was satisfactory, and that it was not intended for the machine to fly. The trial was simply to test the engines." From now onward, we have at least two contemporary and detailed accounts of every test the aeroplane made.

On September 21 the machine was obviously given its first proper test. The journal *Aeronautics* (edited by a former secretary and president of the Aeronautical Society) says: "The first trial was made at Farnborough on Monday, September 21," and added that "no attempt at flight" was contemplated. The *Westminster Gazette* describes the aeroplane as having "gathered speed" and proceeded "at a considerable pace"; and then said "it was immediately seen that the machine was not correctly balanced, the weight being too far forward." The ailerons are also described.

On September 24 the machine was tested again. *The Times* (September 25) describes "a second series of trials . . . witnessed by Colonel Capper. . . . Apparently no attempt was made to rise from the ground." This account also describes the ailerons.

Gradual Progression

On September 28, says *The Times* of that date, tests of the Cody aeroplane "are to be carried out on the same system of gradual progression that has so wisely been adopted by Colonel Capper in his trials of the Nulli Secundus." Col. Capper is quoted verbatim as saying "only preliminary experiments are now being made, with a view to finding out the elements of balance and of control."

On the same day as that issue of *The Times* appeared "a further trial of the military aeroplane was made. . . . No attempt at flight was made" (*The Times*, September 29).

On September 29 "further trials of the military aeroplane were made. . . . Several runs, ranging from a quarter to half-a-mile, were made." During the last run the machine left the ground "for a measured distance of 78 yards." Then appeared these significant words: "Mr. Cody, however, attached no importance to the circumstance, which he said was after all only a jump. He declared further that with the present propellers he will not attempt anything in the nature of a flight. But when he has thoroughly mastered the steering, he says that much larger and more powerful propellers will be fitted to the aeroplane for the purpose of flight" (*The Times*, September 30). *Aeronautics* includes the important technical information that after these tests the ailerons "were removed, as Mr. Cody considered that they could be dispensed with"; also, that "the radiator, which previously extended in a 'V' form in front of the motor, was replaced by two narrow vertical radiators, one on each side of the motor." This change is also reported by *The Times*, and is one of the ways of dating the photographs of the machine.

On October 14 the aeroplane "made several trial runs . . . but in the first two trials, although the two forewheels lifted, it never entirely left the ground. In a third trial, after running for about 600 yards, the aeroplane suddenly sprang into the air, and soared a distance of about 60 yards" (*The Times*, October 15). *Aeronautics* says that "encouraged by this success, Mr. Cody decided to make a more decisive trial."

The all-important day was October 16, 1908—a date not even mentioned by Mr. Broomfield—when Cody made his first and famous proper powered and sustained flight, at the end of which he swerved to avoid a clump of trees and crashed, badly damaging the machine but happily not injuring himself. The distance, officially reported by Col. Capper to the War Office, was 1,390ft. This famous flight was described in detail by Col. Capper, by *Aeronautics*, by *The Times*, by Cody himself in his lecture to the Aeronautical Society in December, and elsewhere. It is this flight —in all its detail—that Cody describes as the last which "came to grief," and not the one on May 16 as your contributor states. It is hard to understand how Mr. Broomfield could possibly slip up here, as Cody's lecture was reprinted and may be read by all: in it he describes exactly the same flight of October 16—with the attempt to turn and avoid the trees—as Capper, *The Times*, *Aeronautics* and others record. There were also excellent photographs published of the crashed machine. Incidentally, there is no trace of any tests being carried out on October 5, the R.A.E. officials of the period having included that date in error.

First True Flight

Capper's official report, and all the other contemporary sources, make it abundantly clear that the test on October 16 was considered by all to be the first proper flight. And Cody himself clinches the matter: after the crash, he said to *The Times* correspondent, "I am sorry that the accident occurred, but I have accomplished what I aimed at; I have constructed a machine which can fly."

Whatever tests were made on May 16—and in view of the evidence, one wonders if anything at all serious took place on that date—it was never thought of at the time as having the slightest significance. What is more, in Cody's long, detailed, and laudatory obituary notice in *The Times*, we read "in September 1908, he succeeded in getting off the ground." Then, in a highly flattering obituary brochure issued at Aldershot by Cody's admiring friends, no mention is made of any flight at all in 1908.

I am afraid Mr. Broomfield is even wrong about the photograph he published in *Flight* last week, purporting to show the May 16 flight. Not only has the machine no ailerons, but the radiators are shown in the position to which they were moved after the tests on September 29. Photographs exist of them in the "V" position, and later in the upright position shown here: they (only one is, of course, visible) are the large slab-like shapes behind the front struts, partly hiding the engine, and appearing—only visually—to be just in front of the control wheel. The horizontal "sail," which Mr. Broomfield says was "later removed," was in fact still in place on October 16, as the crash photographs clearly show.

Mr. Broomfield is also incorrect about wing warping on the machine. This idea—due, I suggest, to a "mis-memory"—stems from Cody's ingenious method of altering the camber of his wings, but this could only be done on the ground. The aviator describes this in his Aeronautical Society lecture: "The curves of my machine are adjustable by screw adjustment . . . I can give them the deeper curve to set the whole machine in a deeper pitch whilst lying on the ground," etc., etc. Cody did not use proper warping on his machines until 1909: apart from the tests of October 14 and 16—when he relied on his two rudders, and on the dihedral angle of his lower wing for lateral stability—he always used ailerons in one form or another, sometimes combined, in 1909, with warping.

Samuel Franklin Cody was a grand old man; but do, pray, let us get the record straight. It does him no honour to claim for him what he never claimed for himself, to claim that nebulous tests and protracted jumps were serious aeroplane flights. After all, we can do the old gentleman much better than that; we can honour him as the first man to make a good and proper powered and sustained aeroplane flight in Great Britain, on October 16, 1908.

Combustion and Propulsion

POINTS FROM PAPERS AT AGARD MEETING

Part 1

THE Combustion and Propulsion Panel of the NATO Advisory Group for Aeronautical Research and Development (AGARD) held its third "colloquium" in Palermo, Sicily, recently. Unlike the two earlier meetings of the combustion panel (Cambridge 1953 and Liège 1955) the papers presented were concerned with general propulsion problems as an indication of the extended scope of the panel under its new title. The moving spirit of the meeting, and leader of the panel's activities, is the indefatigable Dr. Theodore von Kármán. The eighteen lengthy papers, and the accompanying discussions, are to be published in full in the autumn, under the title *Selected Combustion and Propulsion Problems 1958*, by AGARD, from the Palais de Chaillot, Paris XVIe. The following selective summaries of certain of the papers are an indication of the contents of this volume.

The papers were presented in five sessions entitled: I, powerplant requirements related to aircraft mission; II, interaction of combustion systems with other engine components; III, noise; IV, combustion; V, aerophysical chemistry. Most of the speakers came from the U.S.A., but there were some redoubtable contributions from the U.K. and France and one from Germany.

In *Propulsion by Air Breathing Engines*, **Mr. A. A. Lombard**, chief engineer of Rolls-Royce, Ltd., surveyed the present scene in similar terms to his recent R.Ae.S. lecture (*Flight*, January 17), but introduced some new technical information, particularly with respect to high-energy fuels and the ejector nozzle. There may well be no money today for a new British military turbojet, which is a pity, since the fully developed reheated turbojet reaches its peak at M = 2.5-3.0.

Following upon the thrust increases obtainable by adopting double or multi-shock intakes, constant compressor-blade Mach number ($N\sqrt{T}$ control), r.p.m. increase to reduce spillage and a convergent/divergent nozzle, there comes the ejector nozzle. This is little less efficient than a fully-variable con-di mechanical nozzle (see curve) and it is very much lighter, although there may be some loss in gain due to the absence of pressure from the expanding high-pressure efflux on the basal area of the afterbody.

While at high supersonic speeds L/D might, with close attention to interference effects, be kept as high as 50 per cent of subsonic values, the engine efficiency at M = 2.5 will be twice that at M = 1.0, so that ranges akin to those achieved today should be attainable. It is unfortunate that a wing suitable for range flying at M = 2.5 would not permit take-off in a reasonable distance, unless the aircraft were supported by direct jet-lift until its forward speed exceeded the high stalling speed. "Advances made in the construction of lightweight jet engines make it quite feasible to provide the necessary thrust for VTO without uneconomic weight penalty."

Discussing the parameters of air-intake conditions, pressure ratio and engine weight, Mr. Lombard reiterated his suggestion of the turbo-rocket engine as one of the most promising hybrids to meet the conflicting requirements.

Turning from improvement in thermodynamic efficiency by design refinement to the use of "exotic" fuels, Mr. Lombard said that there are three special fuels which may offer advantages over kerosine: fuels of higher calorific value on either a weight or density basis, e.g. other hydrocarbons; fuels of high calorific value on both weight and density, e.g. boron compounds; fuels enabling higher temperatures to be reached, e.g. light metals.

A plot of the calorific values for hydrocarbon fuels against density reveals a virtually unique curve—whether volume or weight is considered—all the way from pure liquid hydrogen to solid carbon because the heat of formation of the compounds is low. Where the heat is large, as in the triple-bond acetylene, the fuel is significantly above average—but is hazardous for that very reason.

Boron, with the same density as carbon, has a much higher calorific value and forms compounds akin to the hydrocarbon series—hydrogen-diborane (B_2H_6), pentaborane (B_5H_9), decaborane ($B_{10}H_{14}$), etc. Unlike CO_2, the boron oxide product (B_2O_3) does not vaporize at normal operating temperatures; it may therefore cause deposition and erosion problems, and when it boils it absorbs much latent heat. Burning boron powder at the high intensity needed in a jet engine would be difficult, since the oxide might condense on unburnt particles and inhibit combustion. Diborane and pentaborane are toxic gases under normal atmospheric conditions. Hydrocarbons with a few carbon atoms replaced by boron atoms could conceivably combine the satisfactory physical properties of kerosine with some of the higher calorific value and good burning properties of boron. Boron: 13,800 C.H.U./lb, if oxide is solid (below 800 deg K); 13,500 C.H.U./lb, if oxide is liquid; 10,300 C.H.U./lb, if oxide is gaseous (above 1,800 deg K); carbon: 7,840 C.H.U./lb.

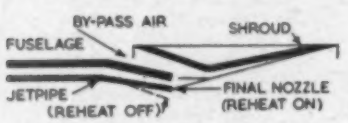
Maximum temperature possible with kerosine is 2,300 deg K, and it is the heat-release per unit mass of total products which sets the limit of gas velocity and thrust. Magnesium and aluminium have very high heat values on this basis, plus high density; it has been suggested that a paint-like slurry of metal powder in kerosine might be stabilized and pumped—though erosion by metallic oxides might prove troublesome.

It is necessary to investigate the ease of combustion of the various high-energy fuels so as to take full advantage of high combustion intensities and so reduce combustion chamber and afterburner sizes by making full use of higher reaction rates and flame speeds. Fuels of higher stability range could be burnt at turbine-inlet temperature conditions so that the dilution zone could be eliminated.

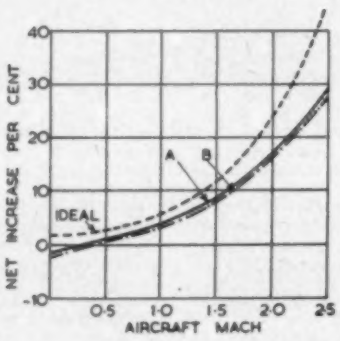
Liquid hydrogen has a calorific value about 2.7 times, and a density only 0.087, that of kerosine. It must be evaporated before entering the combustion chamber and this process could be used for structural cooling—but the aircraft would have to be specially designed to provide the large volume and minimise the surface insulation. The following table is indicative of the effect of two high-energy fuels upon aircraft characteristics (kerosine = unity).

	Liquid hydrogen	Hydrogen-carbon-boron
(A) *Same take-off weight and fuel load:*—		
Range	2.80	1.41
Fuel volume	11.70	0.96
(B) *Same fuel volume:*—		
Take-off weight	0.63	1.02
Range	0.30	1.45
(C) *Same payload/range:*—		
(1) Development:		
Take-off weight	0.72	0.86
Fuel load	0.30	0.65
Fuel volume	3.50	0.63
(2) Re-design:		
Take-off weight	0.46	0.76
Fuel load	0.19	0.51
Fuel volume	2.22	0.49

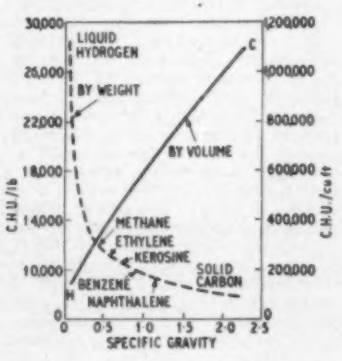
Combustion problems resolve themselves into current and future, i.e., M = 2.5+. In the present, high-altitude relight methods are still haphazard, but "the problems of controlling



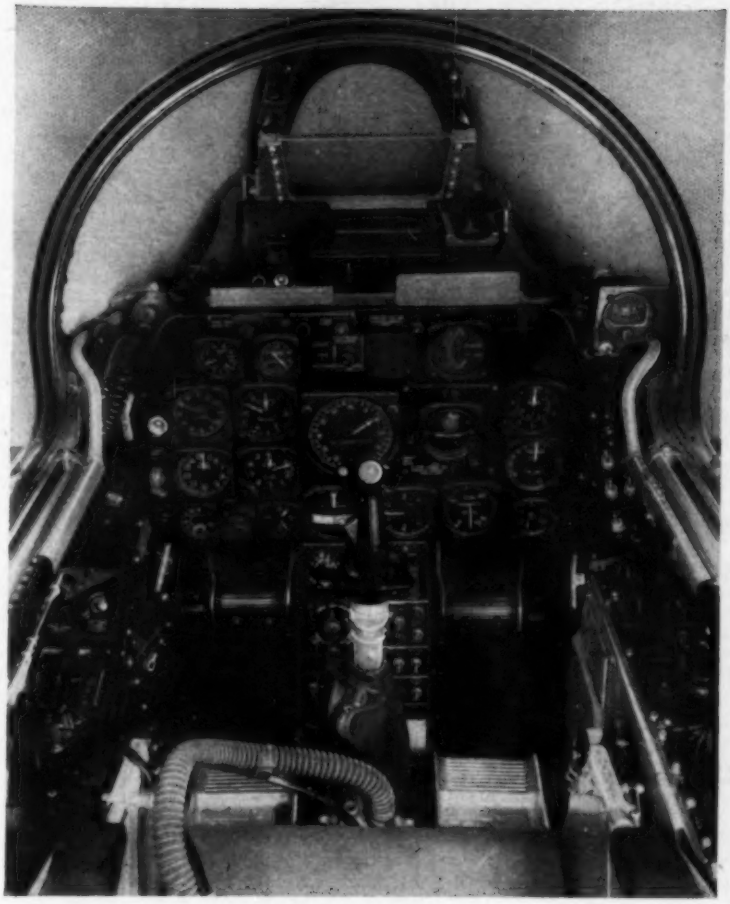
Semi-cross-section through the ejector nozzle discussed by Mr. Lombard.



(Centre) Increase in performance of a typical supersonic turbojet due to A, mechanically variable nozzle, and B, ejector nozzle.



(Right) Performance of some hydrocarbon fuels, plotted against weight and volume.



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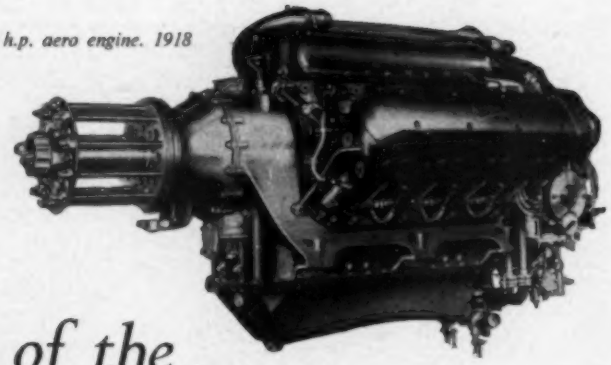

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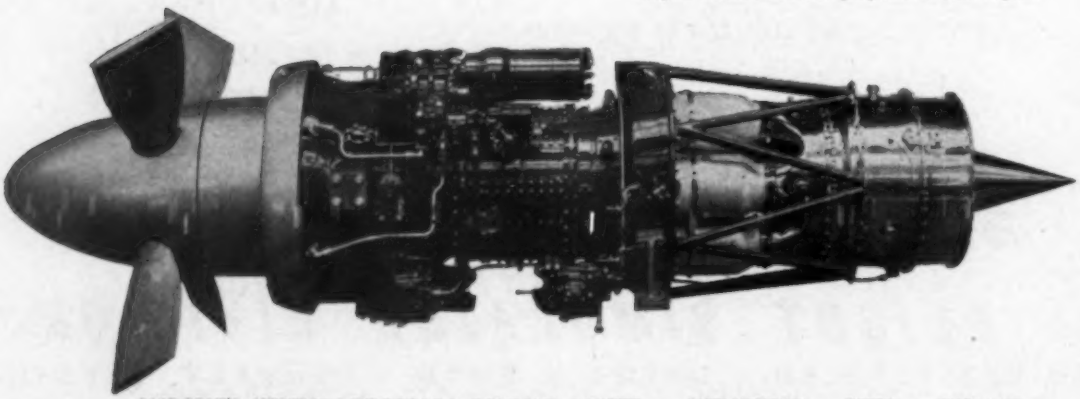

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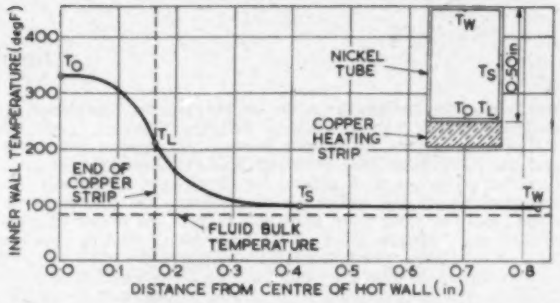
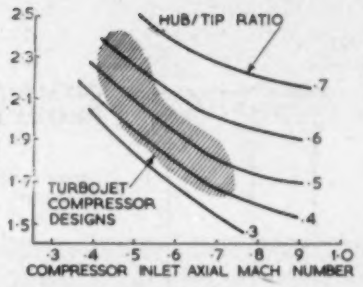


(Left) Temperature profile around a heated tube. The laboratory rig is discussed in the text (Levine).



(Right) Conditions under which engine inlet area becomes greater than compressor frontal area.

COMBUSTION AND PROPULSION . . .

flame-tube wall temperatures are better understood and a consistent flame-tube life of 2,000 hours without inspection has been achieved; efficient skin-cooling at temperatures in excess of 1,300 deg K has produced a flame-tube life greater than other components of the engine." Combustion theory can now be applied by easy, reliable rules, but combustion pressure losses—mainly parasitic and due to primitive mixing methods—could be improved. In the future, M = 2.5-3.0 turbine-inlet temperature and the high compressor intake temperature reduce the mechanical pressure rise required, and the tendency is for the turbine to govern the frontal area. The combustion chamber would be made as small and light as possible—even at the expense of some loss.

Mr. Lombard then repeated his familiar arguments in favour of the by-pass turbojet for the optimum subsonic transport, and developed the theme of integration on the basis of the N.G.T.E. jet flap boundary-layer control on flaps, both the suck-and-blow and Attinello super-circulation, and laminarization.

The opposite approach, the Rolls-Royce/Griffith jet-lift transport, discussed in *Flight* of April 18 and 25, was offered as an economic possibility at M = 2.5, where the un-reheated turbojet attains an η_t of 38 per cent.

The lecturer concluded upon nuclear power, and indicated that powerplant and shielding weight (say 100,000 lb) might be over half the aircraft weight and four times the density of normal propulsion equipment, thus eliminating structural bending relief. After outlining the technical difficulties, including shielding and the radiation crash hazard, he concluded: "What this adds up to is that a nuclear-powered aircraft is possible, and may be demonstrated within the foreseeable future, as a *military* scientific achievement. As a practical military aircraft fulfilling a need incapable of fulfilment in a better manner by other means it is some distance away. A radical development in nuclear reactors will be necessary before the picture can change—but this is not impossible."

Although also presented in the first group, **Mr. Robert S. Levine's** paper *Development Problems in Large Liquid Rocket Motors* was as different in approach as it was in content. Introducing his subject Mr. Levine mentioned non-scientific problems including reliability factors: if a hypothetical missile has 500 components of 99.5 per cent reliability, overall reliability will be $(0.995)^{500}$, or 77.8 per cent; if a 95 per cent reliable propulsion system (also of 500 components) is required, each must be $(0.95)^{1/500}$, or 99.99 per cent reliable; "to prove that any component will not malfunction more than once in 10,000 tries takes much special testing, quality control and inspection." The necessity for lightness, normally incompatible with efficiency, entails careful design, raw-material selection, painstaking manufacture, extensive testing, and redesign—which is where the money goes. Only in a few special cases is any unusual technical knowledge required. The second source of expense is the vast infrastructure necessitated by safety precautions (which increases with the size of the project), the need for remote sites (because of noise, with consequent roads and pipelines) and, as engines get larger, the machinery to handle them. More than a whole eight-hour shift is usually required for a single firing. To keep down costs, models are used wherever possible; often these are designed to simulate one parameter and frequently bear little resemblance to the original.

An example of this last was a two-dimensional model used to study high-frequency combustion instability. This was a one-inch slice across the injector of a 2ft-diam. chamber, wherein alternate paired nozzle-holes inject ethyl-alcohol and Lox, impinging like-on-like to form a flat fan-shaped spray. The model could simulate a tangential acoustical mode of the cylindrical chamber. High-speed photography (14,000 frames/sec) and Photocon Dynagage high-speed pressure pick-ups were used to establish that unstable combustion could arise from the acoustical mode with pressure amplitudes of the order of 100 lb/sq in in a 200 lb/sq in chamber. From the tests it is possible to establish a "stability rating" in terms of the magnitude of the disturbance which will render the combustion unstable. With the use of such a criterion the effect of engine changes can be established in some five to ten tests—as against hundreds of runs to establish the statistical stability of an engine that may already be near 100 per cent.

The walls of large rocket engines are rather more easily cooled than are small ones because the propellant flow-rate (by weight) to the surface requiring cooling is greater. Boiling of the liquid normally suffices to overcome the heat-transfer to the inner wall and maintains the contact-surface within 50-60 deg C of the boiling point at the jacket pressure. However, increasing combustion pressures have naturally been accompanied by higher jacket pressures until the critical pressure of the fluid has been exceeded, and evaporation is no longer available. The heat-transfer phenomena are complicated by the fact that one side only of the jacket is heated. The laboratory rig consisted of a rectangular nickel tube plated to a copper heater bar, the whole being the length of the rocket jacket, and contained within a pressure tube. Ten welding sets could generate 10,000 A, giving a local heat-transfer rate up to 15 B.Th.U./sq in/sec, while a flow of 47 Imp. gal/min could be maintained at 2,500 lb/sq in. Tests up to 6 B.Th.U./sq in with a temperature difference up to 480 deg C compared closely with the Sieder-Tate heat flux equation—an empirical formula evolved with hydrocarbon oils in round tubes with temperature differentials below 150 deg C.

Large rockets have some peculiar ignition problems, particularly local explosions, due to inadequate ignition allowing unlit pockets of fuel to form, which can trigger unstable combustion. Full-scale "slice" two-dimensional models of the chamber, with heavy Lucite sides having a thin internal layer of Pyrex glass to prevent burning, are used to study flame behaviour. The answer to the ignition trouble is to use sufficient energy, distributed across the injector face, plus precise control of the propellant entry. The time-scale of such tests is indicated by the 7,000 frames/sec photography used—with detonation occurring at the fifth and sixth frames in an example. In other respects large engines have a higher performance than small, probably because their scale permits multiple propellant injectors, thus avoiding over-rich concentrations, while the greater physical length of the nozzle (for a given area ratio and expansion angle) allows more time for chemical equilibrium changes in the exhaust.

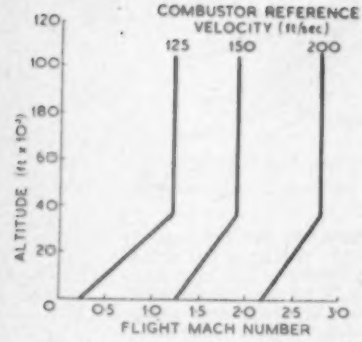
Large rockets present special problems in fluid dynamics. "Water hammer" can be disastrous in a 20ft pipeline of thin-gauge metal where, perhaps, a 2,000 h.p. turbopump comes to full speed in a fraction of a second. Another trouble can occur in a large diameter Lox pipe, perhaps 20ft high, in which the fluid warms as it stands before firing. The hydrostatic head means that there is a higher boiling point at the bottom of the pipe and a bubble will form and force up the column of liquid, releasing the pressure on the superheated Lox, so that a large bubble will "percolate" to the tank, causing severe water-hammer shock as the pipe refills. This cycle must be suppressed. [Typical geometry can be seen in the drawing on pages 706-7—Ed.]

Low-frequency instability arises from a sudden increase in chamber pressure retarding the propellant flow, which in turn reduces the chamber pressure, which is followed by a surge of propellant—the cycle repeating at 10 to 100 c/s. The rule-of-thumb for stability is a pressure drop of one-half the chamber pressure to achieve damping. In large rockets elasticity of the vehicle structure affects pipeline resonance, normally a useful stabilizing adjunct, while the elasticity of the piping and the casing of the turbopump tend to decouple line resonance. In consequence, the minimum injector/chamber pressure drop for stability is 0.15. Theoretically, a high-speed flow control system could be used instead, but it seldom is because of its weight and complexity.

Mr. Levine's final words crystallized his introduction and pointed his moral: ". . . the attainment of good reliability depends on achieving very high reliability in components and assemblies—this is done by straightforward engineering methods."

Mr. J. Howard Childs, of the N.A.C.A. Lewis Flight Propulsion Laboratory, opened Group II with *Effects on Turbojet Combustors and Afterburners of other Engine Components*. Although the "combustor" of a new turbojet is developed on a rig which simulates first-order effects of airflow delivery, it is usual to meet trouble from second-order effects, such as time-varying flow, warped velocity profiles, or acoustic resonance between the rotor and the intake duct.

Transonic compressors today have potential air mass flows of the order of 40 lb/sec/sq ft with high inlet Mach numbers and low hub-tip ratios, which necessitate a turbine with two or more stages if the frontal area is to be kept within compressor dimensions. Above about M = 1.7 the air-intake area will be greater than



Primary-combustor reference velocities (compressor pressure ratio 7; rated mass-flow 40 lb/sec/sq ft of compressor tip area).

COMBUSTION AND PROPULSION . . .

that of the compressor, the exact amount depending both upon the hub/tip ratio and the intake geometry (spike or wedge, area and lip angle).

High Mach numbers require a nozzle exit area much greater than that of the intake if full expansion to ambient is to be achieved, but in practice it is only slightly larger, external pressure losses being more acceptable than nozzle weight. If the combustor frontal area is to be kept within the rotor diameter, then higher velocities will have to be accepted—in turn giving greater pressure drop and heat-transfer rates, leading to deterioration. Similarly, afterburner velocities become too great for efficient combustion; that is why the afterburner is the largest-diameter component on some engines.

The most serious interactions between the primary combustor and the compressor arise from stall and surge, which still cause flameout above about 30,000ft. Air gusts, yaw, high incidence, mismatching of the intake shock configuration in supersonic flight, and the gases from guns and rockets are causes of compressor stall. Missile efflux, it has been calculated, can raise the intake temperature for short periods of 150 deg C.

It is important that the compressor should deliver a sensibly uniform velocity-profile to the combustor at any r.p.m. within the operating range, otherwise considerable losses will occur in mixing, with consequent fall in s.f.c. In turn, the combustor must be designed to provide a temperature-profile matching that required by the turbine, the limits of which are set by fatigue at the blade root, creep along the blade, tip erosion and stator-blade strength at the tip.

Finally, turbine design affects the flow direction into the afterburner diffuser, since it leaves a residual swirl of some 20-30 deg, which may increase downstream at the final injectors to 50 deg, or even 80 deg locally near the centrebody. Flow straighteners cause a pressure drop and power loss, while swirl increases the absolute velocity of the gas stream and there is a pressure loss accompanied by instability.

J. H. S.

(To be concluded)

A.C. *versus* D.C.: OPINIONS CHALLENGED

OUR publication (May 2) of Mr. L. G. Hill's article "Electrical Systems in the Air"—a protest against the change from D.C. to constant-frequency A.C. systems—has brought a commentary from a member of the industry who, writing as "Another chartered electrical engineer," feels that our contributor dragged red herrings across the path of the argument.

For example [he writes], Mr. Hill depicts a defunct starter-generator system with a view to "proving" that electrical systems in general are unnecessarily adorned with gadgetry. It is of course, impossible to conjecture precisely why this particular system assumed the final shape in which it was printed. Possibly it performed more than one simple function, and successive "modifications" led to an incongruous-looking ultimate result. Whatever the reasons, Mr. Hill was aware that it could be quite misleading to make use of devices in this vein in efforts to boost up a "case" suggestive of a welter of superfluous complications in aircraft electrical systems. Present trends are towards the use of light and compact air-turbine starters.

Let us now deal in order with ten "statements of fact" submitted by your contributor:—

(1) Mr. Hill makes but passing reference to the brush-wear problem, but appears to confirm a novel "theory" he propounded at the Aircraft Electrical Systems Convention, 1956—a theory *wholly at variance with established fact.*

Surely he really needs no reminding that there *is* a high-altitude brush-wear problem. He might well make a further study of papers such as that by R. F. Sims (*The Wear of Carbon Brushes at High Altitudes*, Proc. I.E.E., July 1953). Sims offers adequate proof of his main thesis, giving microphotographs of commutator and brush surfaces at low and high altitudes. We may profitably note two short extracts from the paper: ". . . even with a surface like that in Fig. 16(c) the rate of wear is instantaneously reduced to normal when the humidity is restored to its usual level, or if the dry atmosphere is replaced by water vapour alone in the absence of any other gases." Or, "With carbon brushes on copper, the transition between rapid and normal wear as altitude is reduced is *quite definite* and can be easily recognized by the sudden change in voltage drop."

Yet, according to Mr. Hill (who never carried out any investigations whatsoever!) effect of low humidity at high altitude is largely a "general impression." Well-attested observations of the kind instanced are merely dismissed by your contributor, although he seems to think that evidence derived from brush-wear in vacuum cleaners more germane!

(2) In the *Flight* article we further learn that: "The commutator has not changed either in construction or design over the last 50 years. . . ."

Mr. Hill evidently desires to stress something; but if he is trying to suggest that commutators made fifty years ago would be equally suitable today for speeds in excess of 10,000 r.p.m. and temperatures in the region of 200 deg C, he may safely be left to those who know a little more about commutators. As a small point, it may be doubted if electrolytically refined copper and chrome-copper alloys were obtainable half-a-century ago.

(3) On the general issue of A.C. *versus* D.C. systems, another speaker at the Convention perhaps accurately put the position thus: "The new high-performance aircraft will *have* to use A.C. power because *it will not be possible to design D.C. equipment to survive in these aircraft*"—because, it is submitted, of high altitude brush-wear, the ever-increasing power capacities demanded, and high operating temperatures.

Recent requirements sufficiently show that the brush-wear problem, coupled with the increase in electrical loadings, completely rules out traditional D.C. systems.

(4) Your contributor next argues in favour of single-phase generation as against three-phase, but with specific reference to electronic equipment.

It seems unsound to generate single-phase merely to cover the requirements of comparatively light electronic loads, when generators can be produced so much lighter in three-phase form with single-phase loads balanced between phases. Mr. Hill refers to problems such as "differing voltages on phases," and "cross-phasing"—whatever he precisely means by the last-mentioned term. Phase-balance can be readily maintained within prescribed limits.

(5) Mr. Hill may be right to stress the general complexity and what he calls the "gadgetry" of three-phase control systems. However, he seems to confuse such fundamentals as current and voltage; thus, in considering load-sharing between three-phase alternators in parallel, it is line current and not the line voltage that is the important factor. His comparison with central-station (manual) methods of load-equalizing is apt, but again scarcely relevant. The C.E.B. could hardly entertain a shutdown while loads were being manually redistributed!

(6) The article seems to suggest that, because alternators are in synchronism, they will share (real) load within a kilowatt or two; or that, if individual frequency references, synchronizing circuits, and load-sharing devices were dispensed with and the alternators kept "in step" by means of a common frequency reference source, all would be well. But, as Mr. Hill had previously stated, machines usually remain locked in synchronism even though their real and reactive loadings can be widely different. One alternator may be supplying the kilowatts and the other(s) the kVARs. Furthermore, while unbalance of both real and reactive components on a given phase may occur, the net effect reduces to a common torque on the alternator in the case of real power, and a common flux in the reactive case. Although somewhat more difficult, "control" can be made fully adequate to cope with the situation.

(7) Let us enumerate Mr. Hill's objections to rectified A.C. He complains that the circuits shown at the I.E.E. Convention incorporated: (a) Magnetic amplifiers galore, (b) compounding, (c) "cross-compounding," (d) stabilizing and (e) circuits shrieking with bad design.

First, it is a fact that *none* of the rectified A.C. systems in service at the time of the I.E.E. Convention, 1956, incorporated magnetic amplifiers. Carbon-pile voltage regulators only were in use. Secondly, compounding saves weight through reduction in the size of voltage-regulator required, and the weight saved is greater than the weight of the compounding devices. Thirdly, "cross-compounding" appears to be an "innovation." The writer has not heard of it—neither, he thinks, has Mr. Hill. Fourthly, stabilization is not peculiar to A.C. circuits. Perhaps your contributor may care to indicate a D.C. or A.C. voltage-regulating system in aircraft or elsewhere that is not stabilized!

(8) The 112V installation in the Valiant is quoted as a classic example of a D.C. system.

This system was specified by M.o.S. in order to save cable weight, because a generator capacity of 22½kW was necessary and no D.C. machines larger than 6kW had previously been used. Alternative choice would have been either rectified A.C. at variable frequency, or a constant-frequency A.C. supply. Having regard to the capacity and nature of the aircraft loads, the choice was probably a right one, although many problems had to be overcome in switchgear operating at 112V D.C.; also the basic difficulty of transforming energy remains, involving heavy and inefficient rotary transformers or invertors. Even so, it is pleasing to hear that the Valiant is electrically one of the most reliable machines in any country.

(9) Selenium rectifiers (says Mr. Hill) "usually fail on open circuit" whilst germanium and silicon types "fail on short circuit."

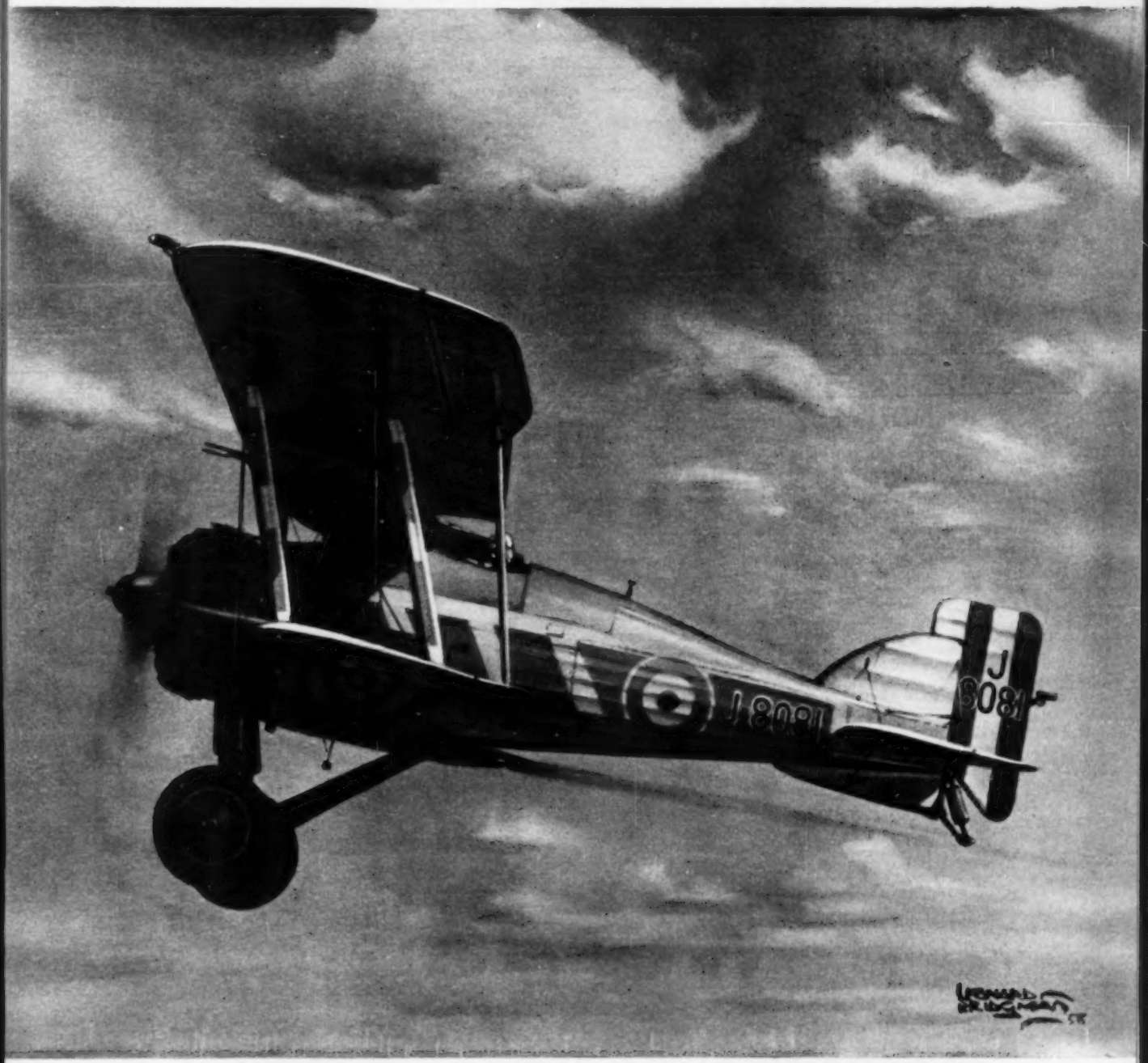
This is but one of many ambiguities or equivocal passages in your contributor's dissertation. Thus, apart from not indicating precise voltage conditions, etc., under which the alleged failures are likely to occur, terms such as "on open circuit," or "short circuit" can evidently signify different things. It would be interesting to learn more concerning the apparently recurring rectifier breakdowns.

(10) Remarks on "control" of the main engine by relatively small alternators do not appear particularly relevant, since such a case would never arise in practice. All constant-frequency alternators necessarily make use of hydraulic, hydromechanical, or pneumatic constant speed drives, designed to be readily controllable, the degree of "softness" being in keeping with exact requirements. Their governors are arranged for correct biasing by the frequency-reference circuit.

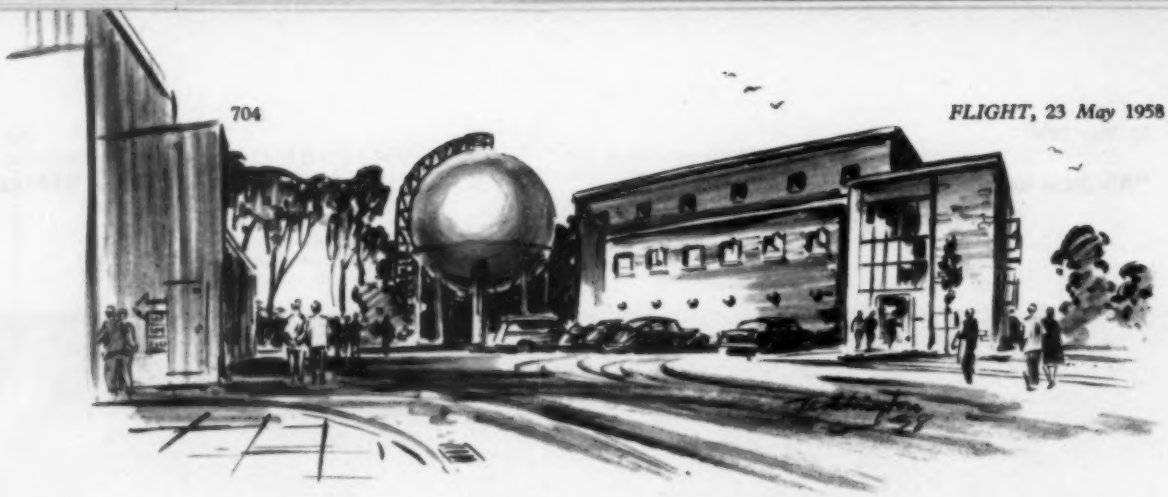
In conclusion, one has uneasy feelings that Mr. Hill has axes to grind, notwithstanding his personal reassurances in the epilogue to his article.

"All these were honoured in their generations,
and were the glory of their times"
(*Ecclesiasticus 44, 7*)

No. 2 OF A SERIES



Gloster Gamecock
NO. 32 SQUADRON, R.A.F.



OPEN DAY AT TEDDINGTON

EACH year the variety and scope of the exhibits at the Open Days of the National Physical Laboratory at Teddington conflict with the limited time available for any one visitor to inspect them. This year's streamlined arrangements, however, featured a relatively small number of displays, showing some of the main research trends, with the laboratory's scientific staff on hand to give details as required of other work in particular specialist fields. Some aspects of Teddington on show, as seen last week by *Flight* artist Gordon Horner, are illustrated on this page.

The West Aero Site sketch (above) is representative of the new-construction programme under way at N.P.L. It shows the recently completed 36,000 cu ft vacuum sphere, which will enable a number of new blow-down wind-tunnels to be brought into use. A compressor house now being built will accommodate a 4,000-h.p. centrifugal compressor and also vacuum pumps to exhaust the large sphere. Recently completed is the workshop building (on the left of the sketch) which houses the Aerodynamics Division design office as well as metal- and wood-working facilities. The building on the right of the sphere is High-Speed Laboratory B.

One of the most intriguing occupants of this laboratory is the hypersonic shock-tube which is illustrated—all 54ft of it—across the foot of this page. Since last year's Open Days the expanded working-section of 15in diameter has been connected to the main three-inch-diameter steel pipe, and much has been learned about the flow in the tube and how to measure its pressure, temperature and velocity. Thin-film resistance thermometers are used for heat-transfer measurements, and a Cranz-Schardin camera, with spark light-source, has been developed to take eight variable-interval Schlieren pictures per run. Typical duration of a run is no more than 0.0005 sec. The tube enables close approximations to full-scale parameters in the re-entry of blunt bodies into the earth's atmosphere to be achieved.

Much of the information gained in the operation of this shock-tube will be applied to a larger version, of 1,000 atmospheres driving pressure and 6in diameter (expanded to 2ft 6in in the working section), which is shortly to be built. Meanwhile, two smaller shock-tubes have been built for the study of the properties of high-temperature gases.

Research on wings and wing-body combinations for transonic and supersonic speeds is another important aspect of the work of the Aerodynamics Division. Examples of this work on show included experiments on two slender delta half-models, and also on sharp-edged plates whose arched planform was described as "Gothic."

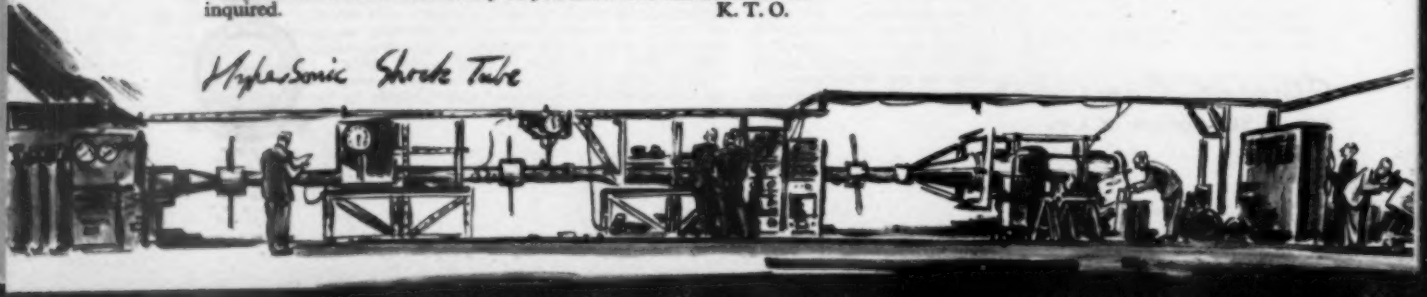
Two Canberra models were on view in the 13ft × 9ft tunnel building. A little late in the day for wind-tunnel testing the Canberra? This might have been fair comment—had not the models been of the P. and O. ocean-going liner as distinct from the English Electric product. The broad heading under which this sort of thing comes is Industrial Aerodynamics, and the particular object, in the case of *Canberra*, was (a) to avoid draughts around the knees of the ship's passengers, and (b) to ensure that smoke did not get in their eyes.

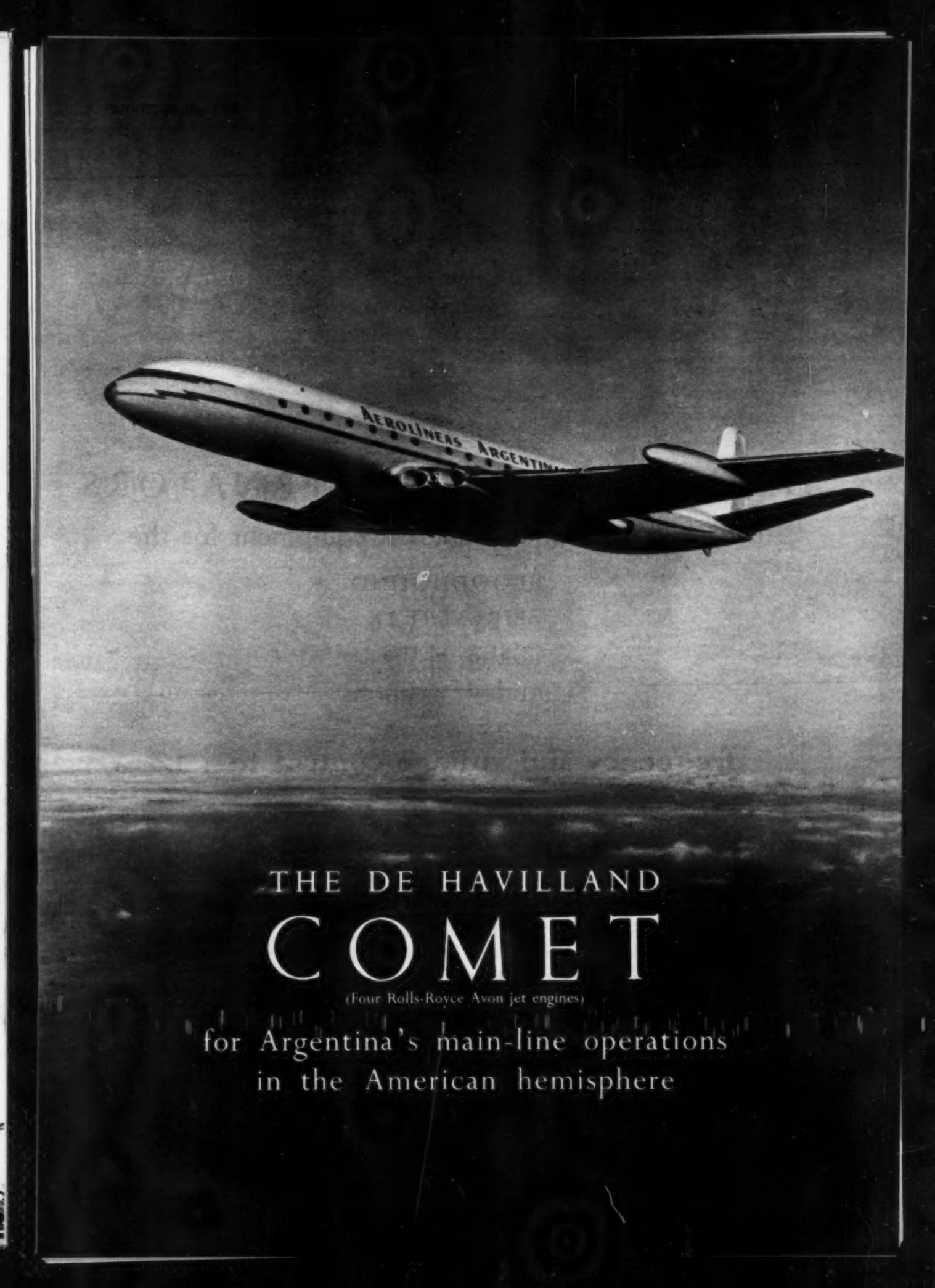
This year's prime attraction at Teddington, however, was the baby, not of Aerodynamics, but of Control Mechanisms and Electronics. Officially designated a conditional probability computor, this box of tricks was cleverly steering a Meccano animal around a black-and-white pattern on a board. It was a machine which could learn from past experience, the demonstrator explained. Obviously impressed, a thoughtful-looking man in his audience turned to a colleague. "How many men in the aircraft industry do *you* know who can do that?" he inquired.

K. T. O.

Workshops exhibit: F.D.2 model previously tested in the compressed-air tunnel at N.P.L.

'Neath the shade of the old whirling arm, visitors' tea is served.





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(Four Rolls-Royce Avon jet engines)

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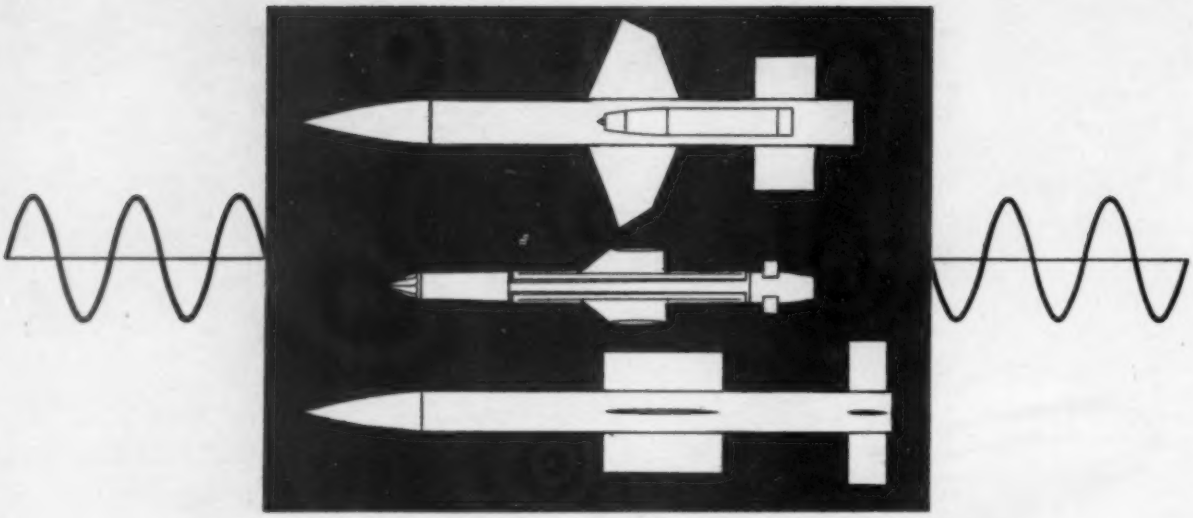

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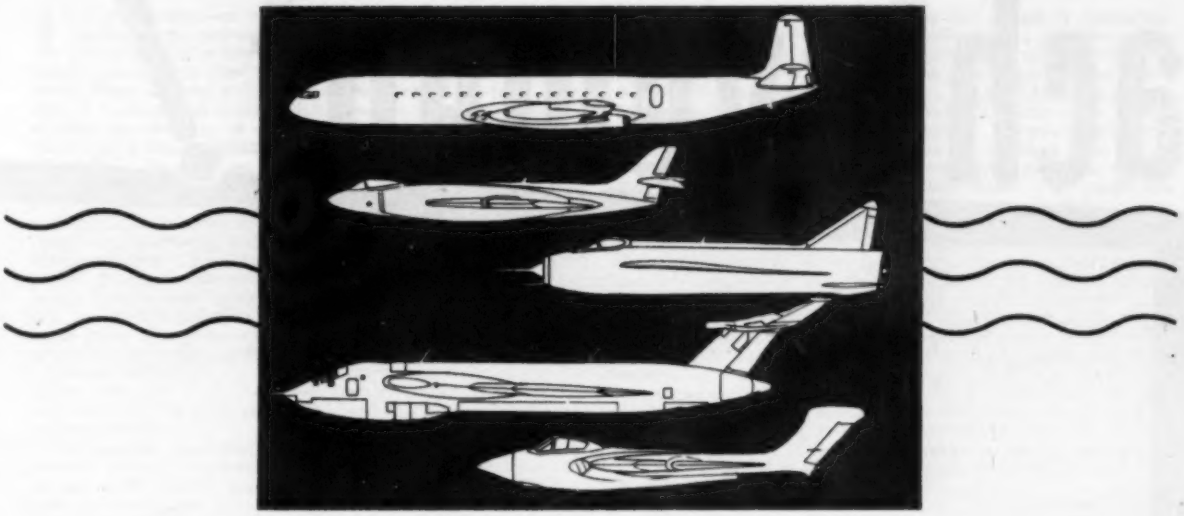

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P.1B

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PROPELLERS · GUIDED WEAPONS · AIR-CONDITIONING EQUIPMENT · ALTERNATORS · PLASTICS

achievement!

On August 28, 1957, at U.S. Naval Air Test Center, Patuxent River, Maryland, in the presence of Mr. Gates, Secretary of United States Navy, Admiral Thurston Clark, U.S.N., Commander Naval Test Center, and many U.S. Navy Officials, Flying Officer S. Hughes, R.A.F., ejected at runway level from a Grumman Cougar taking off. This ejection, the first from ground level in America, was done to demonstrate the Martin-Baker Patent Fully Automatic Ejection Seat at present being supplied for U.S. Navy aircraft. The upper photograph shows the main parachute streaming. On the right, Hughes, immediately after the ejection, is being congratulated by the designer of the seat, Mr. James Martin, C.B.E. Design features of this seat are patented in U.S.A. and Great Britain.

Martin-Baker

AIRCRAFT COMPANY LIMITED, ENGLAND & CANADA

Redstone

The Largest Missile in Service

IT is now undisputed that for certain clearly defined tasks—in particular, the delivery of a large nuclear device to a target whose position is known—the ballistic missile can offer surer transportation than can the most advanced manned bomber. Many *Flight* readers, accustomed to our detailed cut-away drawings of bombers and other military aircraft, may have wondered whether any drawing of comparable interest could be made of something which is virtually little more than a metal cylinder full of fuel. To them we commend the drawing which appears on the two succeeding pages. It is, so far as we are aware, the first such drawing of a modern ballistic missile yet to be published.

Redstone is the name of the great arsenal of the United States Army near Huntsville, Alabama, which houses the Army Ballistic Missile Agency. This establishment has conducted the basic design, prototype manufacture and development of almost every guided missile used by the U.S. Army at the present time. In this, the Army's policy contrasts markedly with that of the Air Force (and, to a lesser extent, the Navy) who have in general farmed out all design, development and manufacture of weapons to private industry. It is worth noting that to some degree the Army have now abandoned the "arsenal" concept; Redstone's successor, the big solid-propellent Pershing, is to be developed by industrial firms.

Nevertheless, this change of heart does not imply that the previous method was either inefficient or basically unsatisfactory for any other reason, although it was naturally the subject of much criticism from American manufacturers and the U.S.A.F. The A.B.M.A. have steadfastly aimed at evolving a thoroughly proven weapon, which could then be handed over to industry with the simple instruction "make it." This has more or less been the case with Redstone.

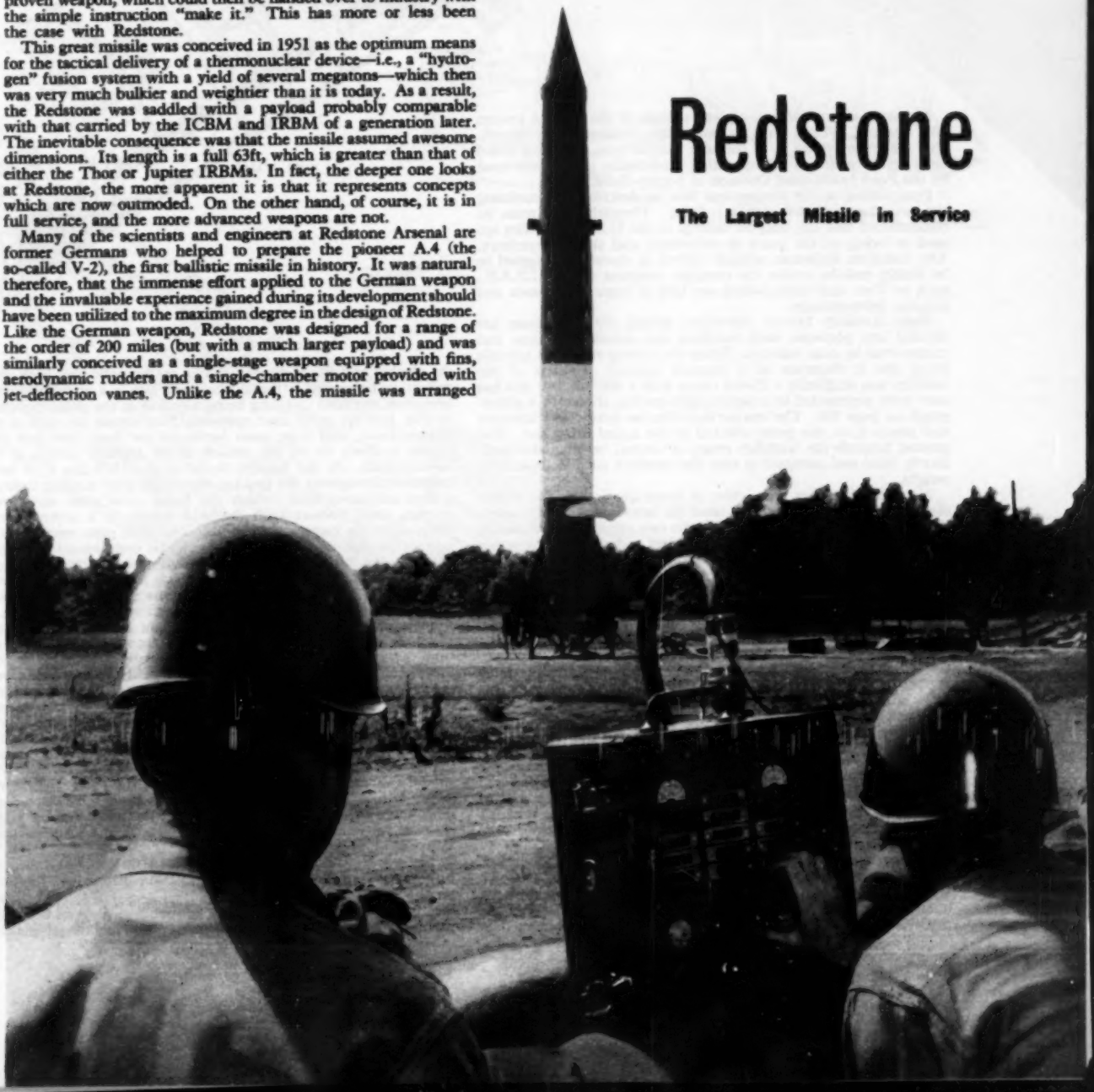
This great missile was conceived in 1951 as the optimum means for the tactical delivery of a thermonuclear device—i.e., a "hydrogen" fusion system with a yield of several megatons—which then was very much bulkier and weightier than it is today. As a result, the Redstone was saddled with a payload probably comparable with that carried by the ICBM and IRBM of a generation later. The inevitable consequence was that the missile assumed awesome dimensions. Its length is a full 63ft, which is greater than that of either the Thor or Jupiter IRBMs. In fact, the deeper one looks at Redstone, the more apparent it is that it represents concepts which are now outmoded. On the other hand, of course, it is in full service, and the more advanced weapons are not.

Many of the scientists and engineers at Redstone Arsenal are former Germans who helped to prepare the pioneer A.4 (the so-called V-2), the first ballistic missile in history. It was natural, therefore, that the immense effort applied to the German weapon and the invaluable experience gained during its development should have been utilized to the maximum degree in the design of Redstone. Like the German weapon, Redstone was designed for a range of the order of 200 miles (but with a much larger payload) and was similarly conceived as a single-stage weapon equipped with fins, aerodynamic rudders and a single-chamber motor provided with jet-deflection vanes. Unlike the A.4, the missile was arranged to split into two parts shortly after the cut-off of propulsion.

The larger part of the weapon consists of the propellant tanks and propulsion unit, the overall length of this section being 34ft and the diameter 70in. As the drawing shows, construction follows roughly conventional aircraft practice, the aluminium-alloy structure being formed from standard rolled and welded sheet, pressed circular frames and other standard sections. The two tank sections are mounted end-to-end so that, when the missile is in its vertical firing position, the oxidant tank is immediately above the propulsion unit, the fuel tank being superimposed. The propellants chosen were liquid oxygen and alcohol, the same as those selected for the German weapon.

Prime responsibility for the propulsion was assigned to the Rocketdyne Division of North American Aviation. Redstone was the first really large propulsion contract to be handled by this company and to speed development it was decided to use a modification of a motor previously developed by N.A.A. for experimental applications. The current production engine is the Rocketdyne A-6, the sixth of the Redstone series, incorporating numerous engineering refinements but basically unchanged from the original A-1 version which entered the static-test stage in 1950. The A-1 was rated at 50,000 lb thrust, and when it went into production in 1952 it was the most powerful propulsion system in the western world. Rated thrust of the A-6 is given as "in the 75,000-lb class." The functioning is described in the firing sequence outlined later in this article.

[*continued overleaf*



Redstone . . .

This drawing depicts Redstone the missile has tilted well ov target; some fuel and liquid

Mounted above the powerplant section is the control system and warhead, which, with its nose-cone, measures 29ft overall. The guidance system is of the true inertial type, and it is based on a stable platform incorporating air-bearing gyros developed by the Ford Instrument Division of Sperry-Rand.

Functioning of the weapon can best be described by outlining the procedure adopted during a firing. Throughout, it must be remembered that the weapon belongs to the U.S. Army, who are used to being on the move in unfriendly and arduous territory. The complete Redstone weapon system is therefore designed to be highly mobile, unlike the strategic weapons of the U.S.A.F., such as Thor and Atlas, which are tied to immovable bases and massive infrastructure.

Field Artillery Missile Battalions armed with Redstone are divided into platoons, each handling one missile at a time and transported by nine vehicles. When the convoy reaches a suitable firing site it disperses in a planned manner. Largest of the vehicles was originally a 25-ton crane with a 90ft jib, but this has now been superseded by a lightweight erector, shown in a photograph on page 708. The erector first lifts the heavy steel launcher and places it on the point selected as the actual firing site. The ground beneath the launcher must, of course, be level and sufficiently hard and compact to bear the missile's not inconsiderable weight.

Next, the launcher crew raise or lower the jacks upon which the launching ring is mounted until the latter is within the specified levelling tolerance. Meanwhile the two portions of the missile are unloaded from their respective trailers and are joined together and the connections made between the two portions. All the circuits associated with the firing and guidance of the missile are then subjected to a thorough pre-flight check-out. Knowing the co-ordinates of the target, the firing crew feed the appropriate information into the programming unit of the guidance system, and this is then "played back" in a dummy run to ensure that the round will function properly.

To the base of the missile is then attached a square frame located on the jibs on the undersides (trailing edges) of the cruciform fins. Two of the corners of this frame are then secured to a pair of feet on the launcher, thus providing an axis about which the missile can rotate while it is being elevated to the vertical position. As a photograph shows, the latter is accomplished by a horizontal H-frame and a pivoting A-frame, the motive power being provided by a powerful winch. In the final stage of erection, the c.g. of the missile passes over the axis of rotation so that the last few degrees are achieved by the missile's own weight, hydraulic dampers beneath the launcher's four pad-feet ensuring that the missile does not overbalance.

As soon as the weapon is vertical, the A-frame is disconnected, thus allowing the H-frame, which carries an inspection platform at the 45ft level, to be raised vertically and aligned against the missile. The numerous electrical and pneumatic connections are made between the launcher and the missile, and at the same time the alcohol and liquid-oxygen trucks are brought up. First propellant to be passed is the alcohol, and this is a straightforward operation, the hose coupling being attached at the point indicated by Fig. 1 in the small inset opposite. Next comes the turn of the oxygen truck, and frost soon forms on the feed hose and also begins to creep up on the outside of the tankage section of the missile itself. As the blueish liquid is at −183 deg C it boils furiously throughout the process, the excess gas escaping through a frost-encrusted hose (which the firing crew treat with great respect, since contact with the skin results in a severe burn). Even after the oxygen tank is full, the feed pipe remains connected, so that evaporation losses can be continuously replaced to keep the tank topped-up. Finally, concentrated hydrogen peroxide is pumped into the tank which feeds the rocket motor turbopump. Throughout these operations the whole missile and launching area is blanketed by a protective fire-fighting fog.

Owing to the great increase in weight during fuelling, the launcher and its load are again levelled accurately. At the same time the upper ring of the launcher is turned in azimuth so that the stabilized platform in the missile's guidance system is precisely orientated in the direction of the target. All this time the check-out and test equipment continues to monitor the missile.

As the launching time nears, all equipment is removed except the missile, launcher, oxygen truck and the firing panel (which is established in a nearby fox-hole). At zero minus five minutes the oxygen line is disconnected and, as the picture on page 705 shows, the vaporizing oxygen spurts from the socket where the overflow hose was previously connected. Final verifications are then made, at the completion of which the firing platoon leader closes the switch which initiates the starting cycle; he is seen doing so in the photograph just referred to.

The starting valves allow the propellants to run down into the turbopump, which consists of two centrifugal impellers mounted on the same shaft as an impulse turbine driven by the decomposing peroxide. When the peroxide stop-valve is opened, the pump turbine runs rapidly up to speed and feeds the propellants

18 Alcohol feed to double-wall chamber

Guidance and Control

19 Stabilizing fins
20 Jet deflectors (two only shown)
21 Aerodynamic controls
22 Control shaft bearing
23 Missile-body controls
24 Stable platform

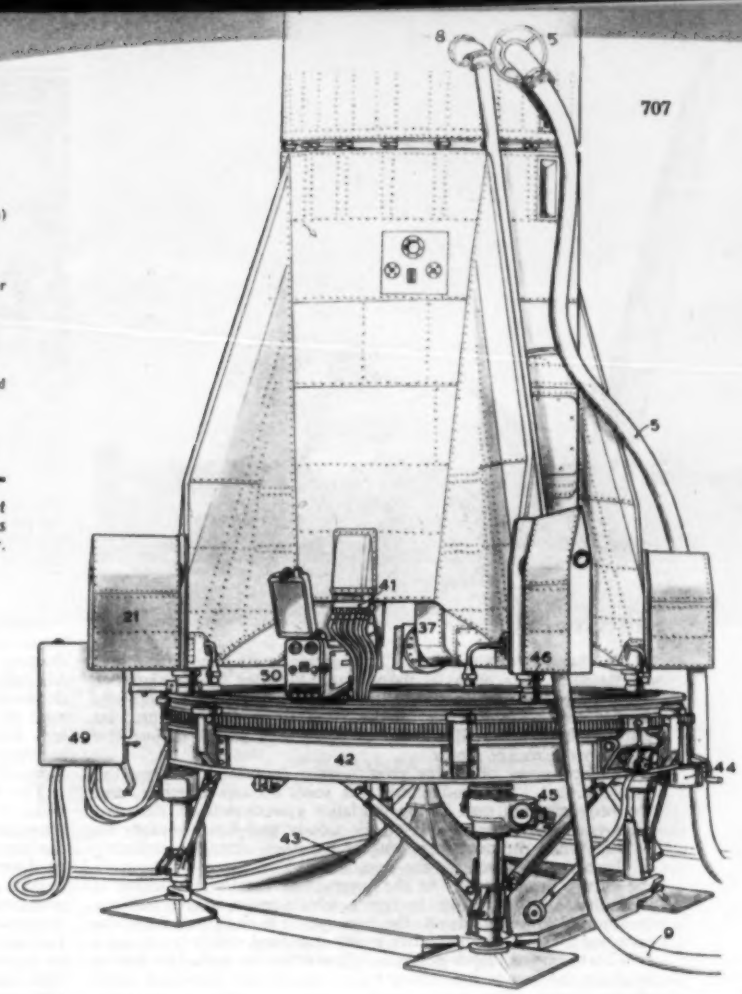
Structure

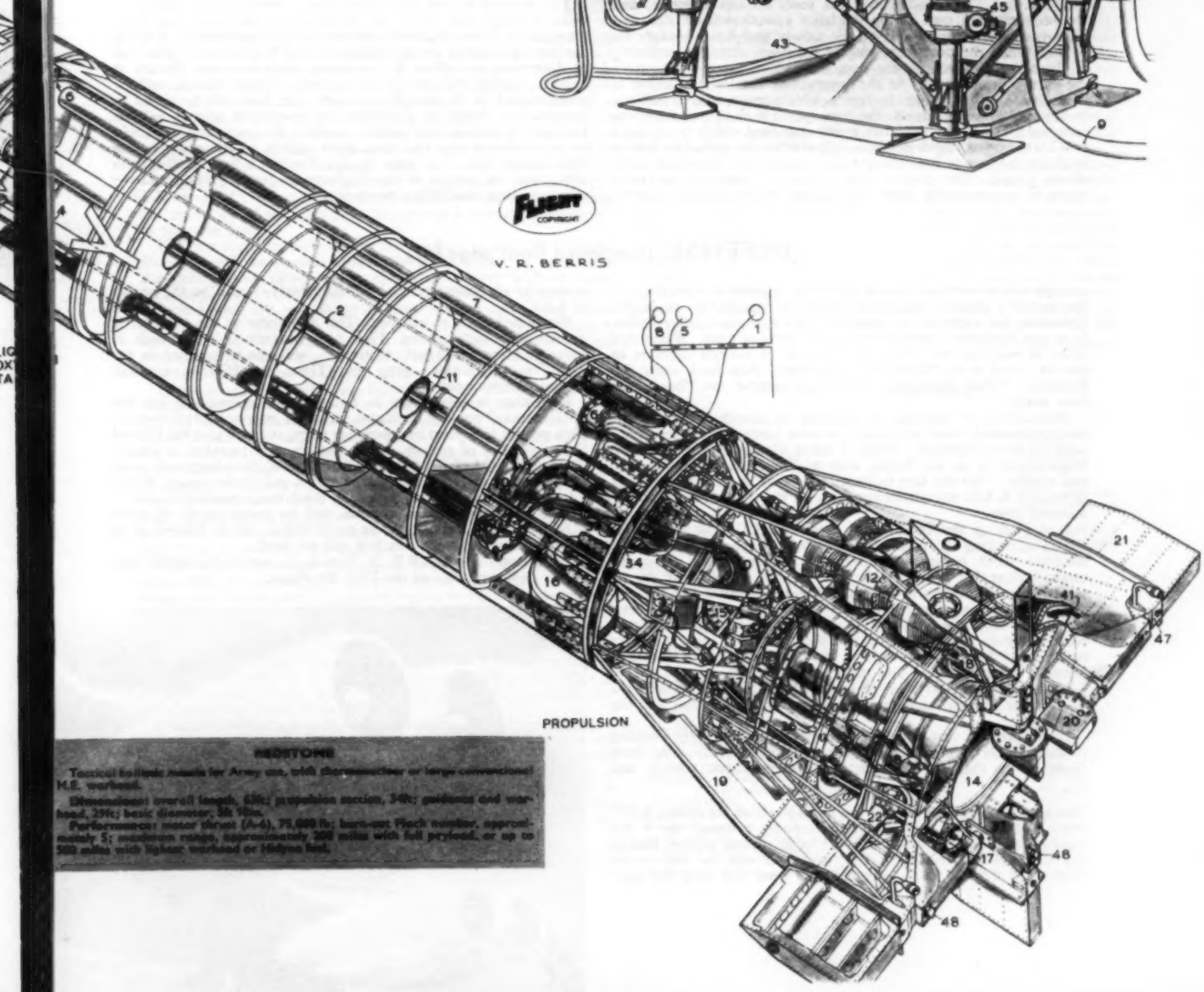
25 Bolt ring
26 Tapered channel stringers
27 Reversed inner cone
28 Nose-cone attachment ring
29 Warhead/guidance access doors
30 Door hinge
31 Hoisting attachments
32 Separation ring (8 bolts)
33 Hydraulic separator each side
34 Assembly joint (20 bolts)
35 Motor thrust channels
36 Access door with gutter above
37 Steel flame-shields (one only shown)

Miscellaneous

38 Tank access cover
39 Multi-pin connections
40 Service duct housing multiple air and electric looms
41 Pneumatic connector group
42 Launcher
43 Blast deflector
44 Azimuth traverser
45 Levelling jack
46 Missile pad, hydraulic damper and tapered-pin location
47 Pad socket on jib of missile
48 Main electrical connector group
49 Main relay box
50 Pneumatic valve box

It might appear immediately after the cut-off point. It will be noted that om the vertical and is established on the correct trajectory towards its en remain in their respective tanks. Inset is a close-up of the launcher.





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V. R. BERRIS

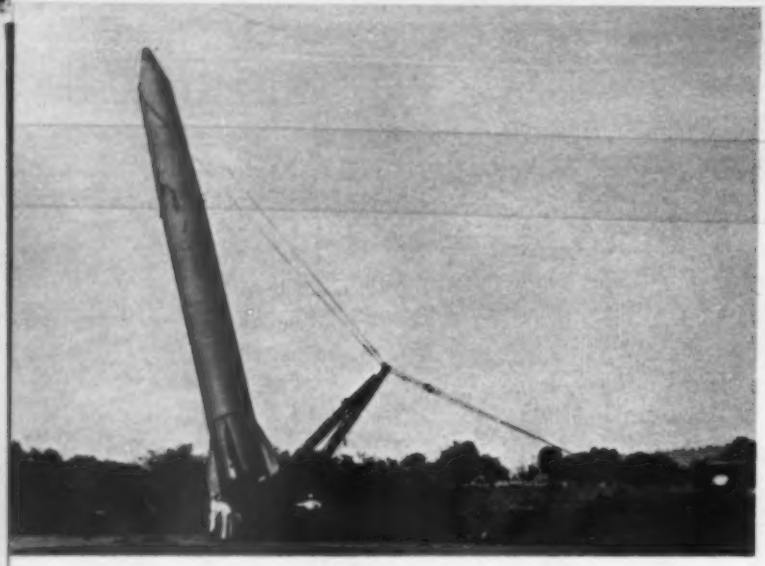
PROPULSION

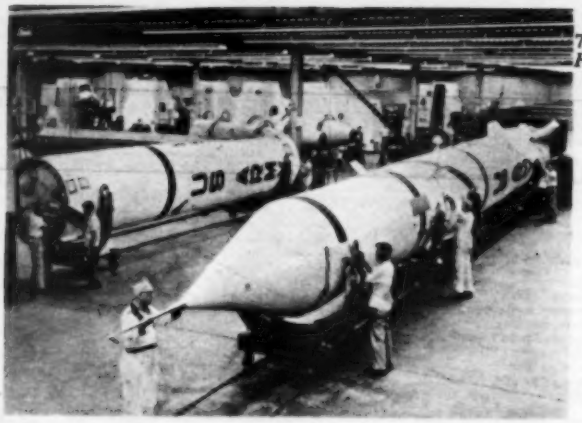
REDSTONE

Tactical ballistic missile for Army use, with thermonuclear or large conventional H.E. warhead.

Dimensions: overall length, 69ft; propulsion section, 34ft; guidance and warhead, 29ft; basic diameter, 5ft 10in.

Performance: motor thrust (A-6), 75,000 lb; burn-out Mach number, approximately 5; maximum range, approximately 200 miles with full payload, or up to 500 miles with lighter warhead or Hidyne fuel.





On the left is seen the raising of a Redstone by means of the new lightweight A frame/H-frame system. The smaller picture shows experimental Redstone missiles in the Warren, Detroit, plant of Chrysler's Missile Operations Branch. Assembly takes place on tracks.

Redstone . . .

to the chamber of the motor. The igniter starts combustion and the flame at once burns at more than 5,000 deg F, the chamber being regeneratively cooled by the fuel which flows through the double wall. Gently the missile rises from the launcher, its stability being assured by the carbon vanes which deflect the jet from the rocket motor.

As the excess of thrust over weight increases so does the acceleration. The aerodynamic fins soon become effective, and the programming unit in the guidance system deflects the controls and causes the missile to tilt slowly and head towards its target. When the necessary velocity has been attained—probably of the order of Mach 5—the missile will have risen well outside the earth's atmosphere. At the appropriate instant, the motor is shut down and thereafter the entire vehicle coasts in true ballistic fashion. Soon after cut-off, the powerplant is separated from the fore-body, the latter thereafter being stabilized solely by its own cruciform of fins. Both portions follow a similar path, but during re-entry the power unit slows more rapidly and falls well short of the target. The missile body, however, continues precisely along its programmed course and should hit the target squarely.

Redstone was first fired in May 1953, and Army Ordnance teams began regular development firings the following year. Production was assigned to the Chrysler Corporation in Detroit, Michigan, and large numbers of the big missiles have since been delivered to field units. Announcement of the first group armed with the weapon was made in July last year; the 40th Field Artillery Missile Group with a strength of approximately 600 was activated and assigned to the Third Army as part of the Strategic Army Force.

The weapon is now fully operational. With suitable modifications its range can readily be increased to 500 miles, and there seems to be plenty of growth-potential in the basic design. During the coming summer several Redstones will be fired from Eniwetok to determine the effect of detonating thermonuclear charges at heights outside the earth's atmosphere. These rounds will be programmed to fly straight upwards; the first will be timed to detonate its charge at 250,000ft and successive rounds will be exploded at increasingly greater heights. In conclusion, it should be remembered that the propulsion section of Redstone—using high-energy fuel—was used to put America's first satellite into orbit; and the success of the Explorer on January 31 proves the value of using established hardware.

W. T. G.

DEFENSE (continued from page 697)

aircraft will be airborne before authority is given to launch—and the positive control procedure makes it impossible, explained Griswold, for a mistake to happen. The execution order comes from the President, through the Joint Chiefs of Staff. When this order is received, the "Go-Code" is sent to aircraft captains in the air. And if no "Go-Code" is received then back come the bombers. "That procedure," Griswold assured me, "has never been used."

Now S.A.C. is turning its attention to missiles. Already an intercontinental Snark squadron has been formed. Thor units are soon to be operational. When I asked Griswold what use the Thor would be in the States, with its limited range, his answer was simple: "It's the first ballistic missile we've got." So it looks as though S.A.C. squadrons armed with the Thor will be purely training units.

It is clear to the Intelligence men at S.A.C. that the Soviet Union is putting its main effort into long-range intercontinental weapons—both manned bombers and missiles. And Griswold makes it clear that we have to face the fact that Russia as an enemy would have the initiative—not us. That is a bitter pill for any military man to swallow—especially a military man who has been trained to seize the initiative as soon and as swiftly as he can. Now, however, the new rôle of the West's bomber force is clearly retaliation. Thus, if you take a basic strength of 1,000 heavy bombers on either side, you must divide by five or even twelve—according to the strength of attack and other circumstances—to discover the real strength of the country which has lost the initiative.

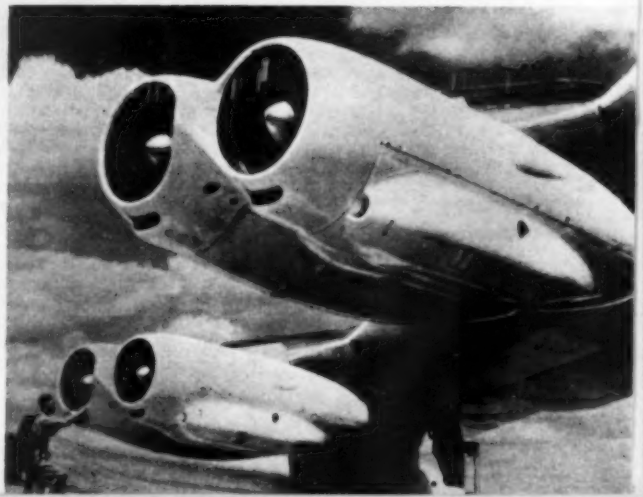
It is apparent that S.A.C.'s main worry is the early-warning system. This explains the spate of space-fiction talk from America, for there is no doubt that a tropospheric vehicle, and eventually an extraterrestrial orbital vehicle, would be the saving of S.A.C.

We talked then of missiles. The Air Force at the moment is preoccupied with getting Thor into operational units both at home and abroad. Snark, it appears, will not be ordered in the usual vast quantities. Atlas and Titan, the ICBMs, are still several months away.

But what is interesting is to hear the enthusiasm for the "Minuteman" concept for a new family of large solid-fuel rockets. This project is beyond the planning stage, and will give the United States a series of rockets which can be used together or singly. Thus an ICBM of the future will consist of three stages all using solid propellants. Separately, the stages will make up an IRBM, a long-range tactical rocket and a short-range tactical rocket.

The "Minuteman" conception will be common to all three U.S. services. As an IRBM or an ICBM it will be housed in an underground silo from which it will be fired.

Next stop: Eglin A.F.B. in Florida, to see the bi-annual firepower demonstration of the U.S. Air Force.



This picture is the first to show the powerplants of the Boeing B-52F. Previous B-52s have had air-bleed accessory systems; the F has Sundstrand-driven alternators, beneath large cowling blisters. Engines are the more powerful J57-P-43W, which will also be used on the "wet-wing" B-52G. S.A.C. wings of both types will form this year.

ITALIAN EXECUTIVE

The Piaggio P.166

By JAMES HAY STEVENS, A.F.R.Ae.S.

A DIRECT adaptation of the well-tried P.136 amphibian, the Piaggio P.166 is aimed directly at the executive market, the structural weight saved by deletion of the planing bottom and wing-tip floats having been applied as much to improving range as to increasing payload. Considerable effort has also been devoted to interchangeability between the P.136 and the P.166, so that wings, engines and main undercarriage are identical. Control runs and systems, for the most part, have common components although, with the redistribution of side areas, an entirely new tail unit had to be designed. However, any user of the P.136 requiring a landplane of greater capacity, range and speed would still have the advantage of a considerable number of common spares.

Use of a shoulder wing brings the c.g. low, so that the fuselage-mounted undercarriage is sufficiently stable, while the cabin floor sits comfortably close to the ground for entry without steps. Advantage has been taken of the aerodynamic requirements inherited from the amphibian to make a deep cabin with ample headroom—no less than 69in on the centreline. A fully adaptable cabin of approximately 300 cu ft volume allows several alternative layouts, but the basic scheme is for two pilots, six/eight passengers, toilet and galley.

Pilots sit side by side, with full dual flying controls and with engine/hydraulic console between, on a slightly raised flight deck. Behind are the four main passenger seats in two rows, either facing one another or all facing forward. The inboard arms of the seats have quick releases which allow them to be folded down and a central squab and back unit to be clipped in. The backs of the central seats are hinged to allow passage through the cabin. The spar bulkhead has a central opening, 59in high and 19.5in wide, giving access to a small bay just ahead of the undercarriage bay. On the starboard side is a full toilet, with a door, and to port there is provision for a galley.

The large windscreen and raised seats give the pilots a good view, while the passenger's windows are of ample size. The passenger door on the port side allows ingress by most people without stooping—it is 54in high by 26in wide. There is a separate pilot's door (43in by 27in), with a rather high step, to starboard, for the cabin can be separated from the cockpit by a plastic "bulkhead." As in the P.136, there is a freight floor aft of the wing with a hatch (35.5in wide by 21in high) in the port side, while there is a large baggage volume available on top of the undercarriage bay—all being accessible from the cabin.

Fuselage lines are deceptively reminiscent of those of the P.136 hull; in fact the fuselage is deeper and the roof rises above the juncture of the gull wings, which have in consequence been separated farther to increase the span slightly. The tailplane is now set slightly above, instead of below, the thrust line and is bolted to two frames which extend above the top line of the fuselage, which is actually level, although the large dorsal fin tends to give it the appearance of being swept up.

Tailplane and elevators are of larger area than the P.136, as also are the fin and rudder. The reason for the backward rake on the latter is partly to increase the rudder moment arm without extending the fuselage, and partly aesthetic, in that it brings the outline in sympathy with the new P.155 flying-boat being built for the Aeronautica Militare.

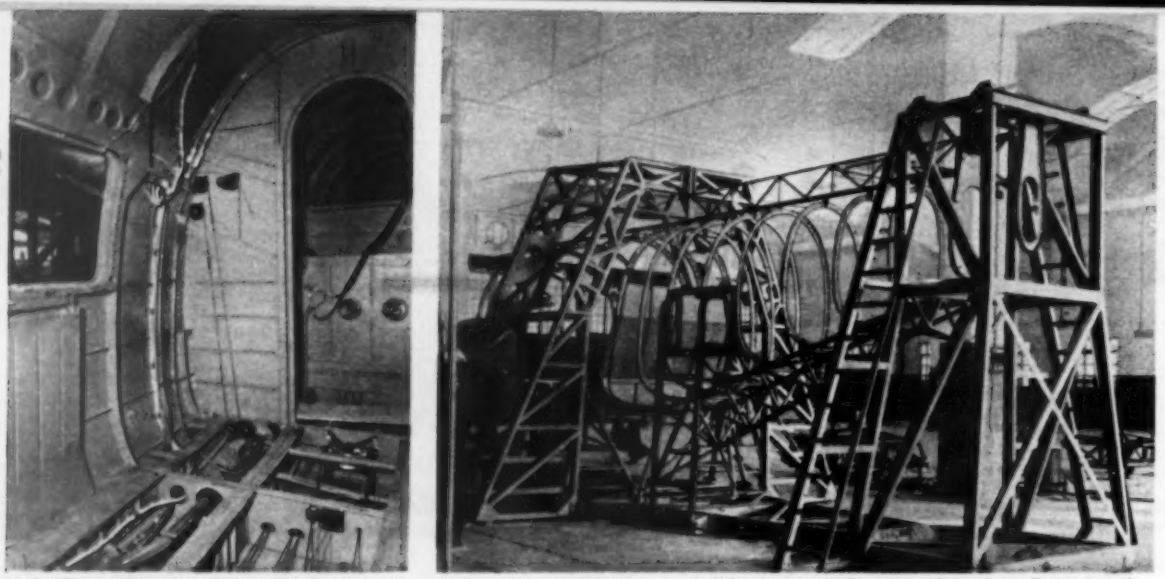
The landing gear is now a tricycle, although it may be recalled that the tailwheel undercarriage of the P.136 produces an almost level ground attitude. The new nose wheel retracts backward into a recess under the flight deck.

Another important modification is that the fuel tanks are now entirely in the wing: a 47 Imp. gal bag tank outboard of each nacelle and a similar bag, of 49.5 Imp. gal capacity, in each wing-tip pod-fairing. The latter are of clean aerodynamic form and have been made deep and narrow, so as to obtain maximum end-plate effect. Transferring the fuel weight to four separate locations has relieved bending stresses in the wing and has enabled the same structure to carry a higher gross weight. The wing is, of course, unusually robust because it was designed to absorb considerable shock loads from the floats. The wing fuel cells will in future be offered as an optional alternative to the fuselage tanks on the P.136.

[*Continued overleaf*

MANUFACTURER'S DATA

Dimensions:	
Span	46ft 9.4in
Length	38ft 7.1in
Height	16ft 4.8in
Mean aerodynamic chord	6ft 5.1in
Wing area, gross	285.89 sq ft
Aspect ratio	7.28
Aerofoil	NACA 230 root NACA 4412 tip
Fuel capacity:	
Wing	47 Imp. gal each
Tips	49.5 Imp. gal each
Total	193 Imp. gal
Weight and Loadings:	
Empty	5,020 lb
Disposable load	2,580 lb
Gross	7,600 lb
Wing loading	26.6 lb/sq ft
Power loading	11.2 lb/h.p.
Performance:	
Max. speed, sea level	202 m.p.h.
10,000ft	225 m.p.h
Cruise, 70 per cent METO, 11,000ft	205 m.p.h.
65 per cent METO, 11,000ft	197 m.p.h.
55 per cent METO, 14,500ft	191 m.p.h.
Rate of climb, s.l.,	
two engines	1,410ft/min
one engine feathered	235ft/min
Service ceiling (100ft/min)	25,600ft
single engine (50ft/min)	11,500ft
Range, 65 per cent METO, 11,000ft	1,300 miles
55 per cent METO, 14,500ft	1,450 miles
Take-off to 50ft	1,550ft
Landing from 50ft	1,250ft
Stalling speed, s.l.	
flaps 45 deg, gear down, power off	69 m.p.h.
flaps and gear retracted	76 m.p.h.



(Left) This interior view of the P.166 fuselage shows window reinforcement, wing-spar bulkhead (note the doorway and spar boom fittings), undercarriage bay, and under-floor control runs and piping. (Right) The assembly jig used for the prototype P.166 incorporates production-type fixtures to ensure full interchangeability. Note the rigid location of the wing spar fittings, the tail attachment points, and the rear baggage door.

ITALIAN EXECUTIVE . . .

Structure. A not inconsiderable factor in the success of the unusual P.136/Royal Gull deal—wherein Italian-built airframe components are shipped to the U.S.A. for assembly, engine, instrument and furnishing installation—is the complete component interchangeability achieved by Piaggio. While the surplus labour situation in Italy has resulted in more handwork (and of a higher standard) than is usual in aircraft today, so that jigging is simple, all attachment points and hinges are rigorously controlled. The general principle is to hold the component by its major member(s) and to locate all attachments and hinges by their operative holes until manufacture is complete, the last operation being to ream the holes to size, using reaming fixtures bolted on the jig frame.

A flush-riveted (an aesthetic concession to American practice) aluminium-coated light-alloy skin is used throughout and the finish of the P.166 prototype closely approaches the high standard of the production P.136.

The fuselage structure is simple, being a semi-monocoque without longerons. Channel-section ring frames, cut to template and hand flanged, are notched to allow the passage of bulbed L-section extruded stringers. Angle gussets, or the turned-over material from the frame notch, are used to join frames and stringers. The window and door cut-outs in the cabin section are compensated by the four deep sheet-metal floor beams, the openings themselves having deep channel-section frames, and there are some pierced-and-flanged reinforcing plates.

The spar bulkhead consists of a sandwich of light-alloy sheet, reinforced by a "core" in the spar-root area, with a T-section flange formed by two riveted L-sections. The bulkhead wall is stiffened by transverse drawn lipped L-sections, the door opening having two sturdy posts formed by top-hat sections, while the arch has lipped L-sections on both faces. The four steel wing-spar fittings are bolted to the bulkhead, with machined light-alloy stress-diffusing channels about five inches wide.

Two transverse half-bulkheads beneath the wing support the tubular main undercarriage assembly and transmit the loads into the fuselage skin through the adjacent frames, which have solid webs in their lower halves and lightening holes in the deeper channels of their upper segments. The space between the half bulkheads is boxed over so that the undercarriage is in a self-contained tunnel.

Aft of this bay there are the reinforced freight floor and the mounting table for the autopilot. The last two fuselage frames are more robust and are extended upward to take the tailplane and fin mounting brackets. The dorsal fin is a light separate structure riveted to light stiffening channels inside the skin. The tail "cone" fairing is detachable for access to the flying control couplings and is located on four spigots with quick-release fasteners. There is a tubular steel tail bumper, inside a fairing, with a small dashpot and skid.

Fixed tail surfaces are conventional, with two folded light-alloy sheet spars and similar ribs. The rudder and elevator surfaces differ from the fabric-covered ailerons and flaps of the P.136, in that the structure is similar to that of the P.149. There is a channel-section sheet metal spar, with a D-skin leading edge, two end ribs, hinge ribs and a skin stiffened by recessed beading. Welded-steel hinge brackets with self-aligning ball races are used. The surfaces have, variously, inset-hinge, horn, and mass balances.

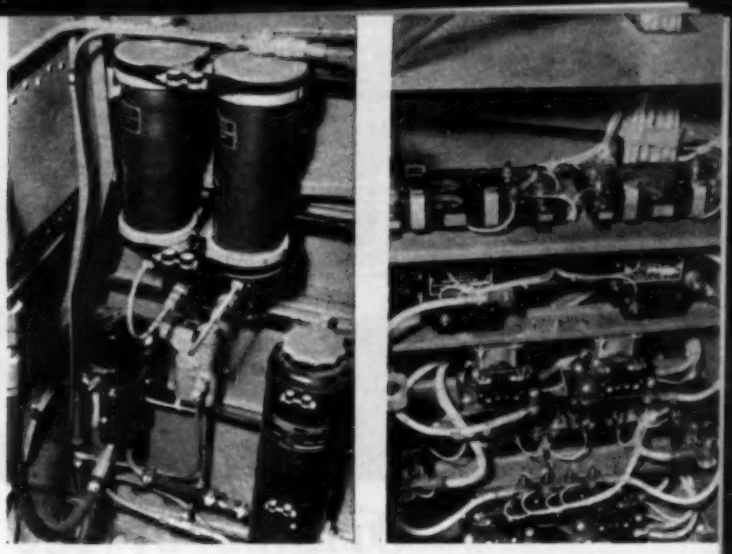
The cranked wing is built in two halves, bolted directly to the fuselage without any centre section. The gull layout is, of course, a legacy from the flying-boat and the need to keep the aircrews clear of spray. The aerofoil section is a thick, relatively high-lift one and it provides more structural depth than is common today. Washout to a thinner tip section insures good stalling characteristics with ample control.

A main spar at 25 per cent chord—of I-section formed by a plate web with backed L-section extrusions for the booms—takes the bending loads, torsion and drag being catered for by the box formed by the light (folded sheet) rear spar, the ribs and the skin with its spanwise stiffeners. The rear spar carries the welded steel flap and aileron hinge brackets. Ribs are light-alloy pierced, flanged-blanks, save in the newly introduced tank bay, where they are of sheet but with deep channel flanges to which outer and inner skins are riveted. The leading-edge ribs are of similar pierced-and-flanged form, joined by a leading-edge channel and intermediate spanwise members, over which the skin is wrapped in sections from boom to boom of the main spar. The rear spar is finished with shroud sections for the flaps and ailerons.

The flaps are built with a single spar, which forms a box with the leading-edge D-skin, and flanged ribs, skin with spanwise stiffeners and a V-section trailing-edge strip. The ailerons have been modified from the original P.136 structure to bring them in line with the tail control surfaces.

Engine mountings of welded and bolted tubular construction are cantilevered from box structures each formed by two reinforced ribs and a connecting false spar, or web, at about 50 per cent chord, the rear spar being interrupted at this point. The Lycoming engine is mounted on four anti-vibration mountings set at 45 deg to the vertical. The front cowling of the nacelle contains two cooling-air ducts and a central intake, behind an ornamental grill, the top half of which feeds the oil cooler and the lower the supercharger. Engine and accessories are completely accessible, with upper (triple) and lower (single) hinged cowlings—hinged at the front thanks to the pusher installation. The engine is isolated

Even with tip tanks fitted the P.166 prototype presents an aerodynamically clean front view.



Practical evidence: the hydraulic system supply group in the fuselage, showing the electric pump, reservoir and accumulator cylinders; and (right) the electrical system cut-out panel.

from the wing structure by a transverse and two fore-and-aft firewalls. The first aircraft had manifolds and single outlet pipes, but three individual pipes on each side in a shielded outlet duct are now being tried. This is not an induced-flow cooling system, since the pusher installation has an open back end to the cowling.

For the American market 340 h.p. Lycoming GSO-480-B1C6 engines will be fitted, with three-bladed Hartzell constant-speed, fully-feathering propellers. For Europe the new fully-feathering Piaggio P.1033 propeller would be used and, if orders warranted starting a fresh engine line, a Piaggio-built engine would be offered. Piaggio have now been building the Lycoming GO-435 and GO-480 for several years and have gained great experience by the overhaul of many hundreds of the "O" (horizontally opposed) engines used by the U.S. forces in Europe and Africa.

Identical with that of the P.136, the undercarriage consists of a complete assembly which can be slid in and out of an athwartship bay for repair and it is functionally tested before assembly. It consists of a triangular welded-steel-tube fixed framework carrying at its apex the actuating jacks which rotate bell cranks that raise and lower break struts hinged to the shock-absorbers, in turn pin-jointed to the welded tube pyramids carrying the axles. Precision welding of the components is done by Piaggio, but the jacks and shock-absorbers are supplied by Oleopneumatica Magnaghi of Milan. Wheels and disc brakes are by Goodyear. The nosewheel unit has a welded-tube fork and retracts backwards.

Systems. The fuel system is simple, with tankage, as already described, giving a total of 193 Imp. gal. The tip tanks are simple two-shell fairings with a floor member to support the bag.

Flying controls consist of dual handwheels, connected by a cross tube and chain-and-sprocket drive, ahead of the dash, to a single vertical column. The hanging rudder-pedals, which have toe-operated hydraulic brakes, are mounted on individual torque-tubes with a cross link that is connected to the control run. Cables are used throughout, with the interpolation of tie-rods, chains and sprockets where required. The flap actuating mechanism is a system of tubes and bell cranks operated by a single jack in the fuselage.

The hydraulic system follows the well-tried pattern of the P.136—an electrically-powered pump, acting through twin piston-type accumulators, with an emergency handpump. The system supplies the alighting gear, flaps and brakes.

At the time of writing details of the production electrical system were not available, but it will be such as to cater for extensive radio, lighting and galley services. Optional extras to be offered will include a combustion heater (mounted in the wings), Goodrich de-icing, oxygen, Federal autopilot and even radar.

One was impressed, when visiting the Piaggio works at Finale Ligure, near Genoa, by the workmanlike production jigs upon which (early in February) the third airframe was approaching completion. The same rigid location of component attachments was to be observed as on the P.136, P.148 and P.149, each of which has been produced in quantity since the war. There was also the static-test fuselage, which had been proof-loaded and showed no scars or wrinkles from its experience. The second aeroplane was on final assembly, while the prototype had done over thirty hours' flying since its first flight on November 26.

Of the five Piaggio designs built since the war, four have gone into production—the fifth, the P.150 military trainer, won its competition, but the Aeronautica Militare then decided to switch to jet advanced training.

HILLER ROTORCYCLE IN BRITAIN

AS we reported last week, the Hiller XROE-1 Rotorcycle has been demonstrated in Britain. France, Italy, Germany, Switzerland and Holland have also been visited—with, it is understood, encouraging results; military orders for evaluation quantities may follow, with ultimate licence-production in Europe. The Rotorcycle, originally built for the U.S. Marines, was granted a C.A.A. experimental C. of A. on January 24. After a public appearance at the South Bank site in London last week, demonstrations were also to be given to the M.o.S., Army, Royal Navy, and R.A.F. at, variously, Boscombe Down, Middle Wallop, Lee-on-Solent and during a Royal Marine exercise. Civil authorities and industrialists were also being shown the Rotorcycle.

The machine has a riveted light-alloy body containing the Nelson four-cylinder, two-stroke, single-ignition 42 h.p. engine, mounted vertically. (The U.S. Marines have accepted single ignition as suitable for standardization.) The drive-shaft turns a cooling fan in a plastic shroud and then the main reduction gearbox, clutch and freewheel housed in castings atop the body; some 4,000 engine r.p.m. are reduced to 540 r.p.m. at the 18.5ft main rotor. The tail-rotor drive is led down the centre of the detachable tail-boom. Each main-rotor blade is made up of a rolled-steel leading edge bonded to a channel-section spar, to which are also bonded trailing-edge surfaces closed by a plastic strip (plastic may later be replaced by magnesium to improve fatigue life).

Shoulder-harnessed, the pilot sits on a completely exposed saddle seat. Instruments and toe-pedal directional controls are mounted on the foremost of three tapered-tube legs each terminating in "bear-paw" dishes. No adjustment of the tail-rotor control cables is needed before each flight. Only an A.S.I., r.p.m. gauge, cylinder head-temperature dial and an ammeter are fitted. Engine-starting is by pull-cord; and the 2.5 U.S. gal tank holds a mixture of 80-octane petrol and 30-grade oil. A 12 U.S. gal tank will later be fitted, together with an electric starter.

The Rotorcycle can be folded by withdrawing pins from the attachment lugs between major components, the tail-boom being completely withdrawn; and the folded machine can be packed in a container which, measuring a mere 27in × 14ft, could be dropped by parachute. A special trolley was used during the tour and the whole "package" was stowed in a small Mercedes 12-seater bus. All-time record for assembly is 1 min 50 sec.

At the Elstree and South Bank demonstrations the Rotorcycle behaved well despite troublesome winds, and stability was sufficient to allow hovering with the cyclic control free. Engine noise, relatively high-pitched, was certainly not excessive. Standard helicopter demonstration manœuvres were carried out with confidence. Autorotation at about 600 r.p.m. could safely be achieved from the hover from about 200ft, and with forward speed there should be no difficulty at any height. The pilot was not, apparently, bothered by his completely exposed position: as for weather, it was like riding a motor cycle—suitable clothing and personal hardiness decided the limitations.

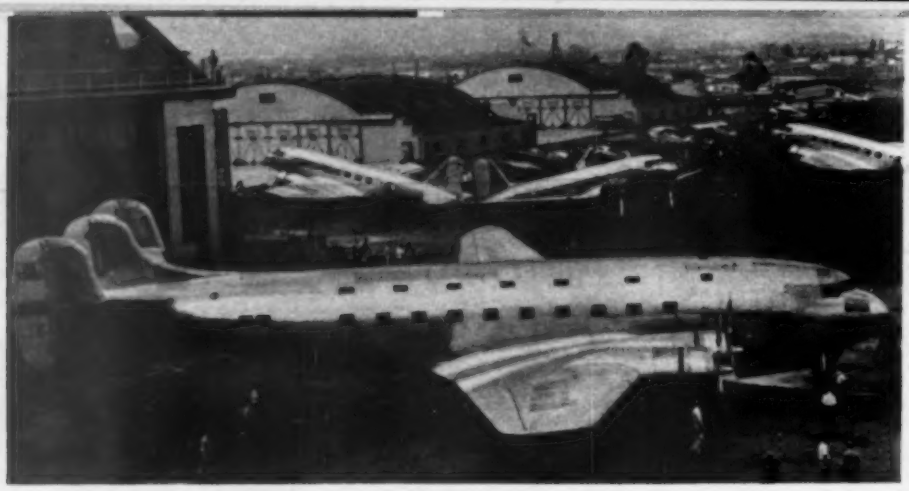
Military uses for the machine are manifold, including traffic direction, artillery spotting, telephone-cable laying, dropping of rescue packs, use as an air-dropped rescue machine and infiltration. Civil uses are analogous, covering aerial inspection and short-range transportation and police work. But much remains to be done to obtain full civil certification, mainly in the clearance of the engine for general use (some 70 or 80 Nelsons have been built). An expected increase of power from 42 to 45 h.p. should greatly improve performance.

The XROE-1 has been flown with a Lear Arcon yaw-stabilizer, which successfully provided automatic directional control.

Loading data: rotor diameter, 18.5ft; max. length, 16.5ft; height, 7.4ft; empty weight, 300 lb; max. gross weight, 556 lb. Performance, with 180 lb pilot only: max. climb at s.l., 1,160 ft/min; max. speed at s.l., 70 m.p.h.; cruise, 52 m.p.h., max. range, 166 miles; fuel consumption, 11 m.p.g.

Richard Beck, Hiller test pilot, wearing a bright orange suit, prepares to fly the blue and white Rotorcycle at Elstree. An initial price of £4,000 could be reduced to £2,000 in production.

"Flight" photograph



"The one and only DC-4E prototype was . . . flown on June 7, 1938."

Origins of the Modern Airliner

PART 4: THE DC-4 GENERATION

By PETER W. BROOKS, B.Sc., A.C.G.I., A.F.R.Ae.S.

THIS is the concluding part of Mr. Brooks's article, the previous instalments of which appeared in our issues of April 11 and 25 and May 9. The author wishes to express his indebtedness for assistance given by Messrs. B. S. Shenstone, S. F. Wheatcroft, D. Sawers and J. M. Stroud in its preparation.

RETURNING to the American scene, in mid-1935 discussions started between Douglas and the five largest American airlines—United, American, T.W.A., Eastern and Pan American—about a new four-engined trunk-line aeroplane. In March 1936 each of these airlines put up $100,000 (£20,000) for the design and construction of a prototype, which was put in hand. The one and only DC-4E prototype was completed and first flown on June 7, 1938. It was a very large aeroplane for its time, with a wing area of 2,155 sq ft—not quite as big as the Ensign, but bigger than the Ju 90 and more than double the size of the DC-3—and was the first American airliner to adopt the four-engined low-wing monoplane configuration already pioneered in Europe. Construction was of the now standard 24S alloy and the wing was also of typical Douglas design. It had a split flap under the centre-section and plain flaps outboard. The loaded weight of the DC-4E was initially 61,000 lb but this was later increased to 66,500 lb. There were passenger seats for 42 people, accommodated in abreast pairs each side of a central aisle. The aeroplane at first had triple fins and rudders, but these were later changed for a more convential single unit.

In spite of many impressive features the DC-4E was a failure and was not proceeded with. It was, however, important as the first large aeroplane to have the tricycle-type undercarriage that was to become a standard feature of the "DC-4 generation." It was also the first transport to have power-boosted controls, alternating-current electrical system, an auxiliary power unit and new specially-developed Pratt and Whitney R-2180 engines. In addition, it was the first American airliner with flush-riveted skin, a practice which had, however, been adopted earlier in Europe; U.S. manufacturers had previously used mushroom-headed rivets. More significant was the fact that the DC-4E was also the first transport aeroplane designed to performance standards which, since the war, have become the basis of modern airline operation. The conception of catering for the "worse case" failure of an engine became feasible for the first time with four engines. N.A.C.A. data on basic control and stability requirements were included, also for the first time, in the airlines' specification for the DC-4E.

The airlines which had sponsored the DC-4E were not all entirely happy with what they were getting, but it was a considerable time before the project was finally dropped. In mid-1936, when construction of the prototype was still at an early stage, two of the sponsor airlines (Pan-American and T.W.A.) started discussions with Boeing about a possible civil transport development of the B-17 bomber, which had appeared in prototype form the previous year. The Boeing 307 Stratoliner was considerably smaller than the DC-4E—it had 30 per cent less wing area—and employed the wings, tail unit and tailwheel undercarriage of the B-17 but, like the Douglas, incorporated a large-diameter circular-section fuselage which was intended to be pressurized. The wing was a two-spar structure mainly of conventional aluminium alloy, as was the remainder of the airframe. Some use, however, was also made of steel.

The 307 prototype made its first flight on the last day of 1938. Well before this, in the spring of 1937, T.W.A. had ordered six 307s and Pan-American three and had thus helped Boeing to finance the project. Pan-American were particularly keen on the pressurization feature and specifically helped to finance its development. An accident to the first aeroplane in March 1939, when it suffered structural failure while coming out of an accidental spin during a demonstration flight for K.L.M., caused delays, but development went forward and the production aircraft were given larger vertical tail surfaces. The type was also developed to take more powerful Wright Cyclone engines and—in the Model 307B—the flaps were changed from the split to the slotted type. The first 307 was delivered to Pan-American early in 1940 but the first to go into service were five 307Bs of T.W.A. which were used on the transcontinental and New York - Chicago routes from April 1940. Later the 307s were used by T.W.A. for transatlantic services on behalf of the United States military authorities. The 307, like the Lockheed 14 before it, had full-feathering constant-speed propellers. It was also the first transport aeroplane to be put into service with cabin pressurization. The pressure differential was 2½ lb/sq ft, equivalent to a cabin attitude of 8,000ft when the aircraft was at 14,700ft. Although technically a success, the Boeing 307 was not produced in numbers.

The DC-4E prototype was handed over to United Airlines in 1939 and was evaluated for a time on their routes. It received C.A.A. certification on May 5, 1939. United contemplated ordering a 52-passenger version but, in the end, the sponsor airlines agreed that the DC-4E was not what they wanted. There was "too much aeroplane" for the job to be done and the feeling was that an aircraft more of the size of the Boeing 307 was what was required. The DC-4E prototype was sold to Japan towards the end of 1939.

In mid-1939, as a result of airline reaction to the DC-4E, Douglas started work on an entirely new design. Construction of the first aircraft started early in the following year, by which time war had broken out in Europe. The new aeroplane, also known—confusingly—as the DC-4, was considerably smaller, structurally more efficient and aerodynamically cleaner than the DC-4E. Its size was, in fact, similar to that of the Boeing 307 with a wing span of 117ft 6in and an area of 1,457 sq ft (Boeing 307: 107ft 3in and 1,486 sq ft) The power units were four of the new Pratt and Whitney R-2000 radials of 1,350 h.p. and the layout was similar to that of the DC-4E, although the wing was of higher aspect-ratio. The wing was of the same N.A.C.A. 23-series section—16 per cent thick at the root and 12 per cent at the tip—but had slotted flaps. The design wing-loading was increased from 28 to 34 lb/sq ft. The inner wings were of typical Douglas "multi-cellular" three-spar construction but the outer panels had single webs and heavy booms—which suggests that the structural attractions of the technique used in the DC-2 and DC-3 had still not been fully appreciated. The initial design gross weight of the DC-4 was 50,000 lb but this was soon increased and the production aircraft were operating at 73,000 lb before the end of the war. The tail was a simple single fin and rudder unit of clean design. The undercarriage retracted vertically into the inner engine nacelles instead of laterally into the wings as it had done on the DC-4E. Structure was again mainly of 24S aluminium alloy. The fuselage was a long "parallel-section" tube of slightly egg-shaped section. An internal cabin-width of 118in provided space for two-and-two seating in seats 24in wide on each side of a 22-inch aisle. These figures represented a substantial advance even on the two-and-one layouts of the DC-3. Later, this same DC-4 fuselage section—the fuselage section seems to be one of the few immutable things about a transport aeroplane—was to take five abreast (three-and-two) high-density seating in versions of the whole DC-4 to DC-7 series.

Sixty-one of the new DC-4s were ordered "off the drawing

Douglas C-54 (above): "By the end of the war 1,163 of the military versions of the DC-4 had been built."

The prototype Boeing 307 on a test flight in January 1939 with its starboard Cyclones feathered.

board" by several airlines, including American, United and Eastern, for use on the U.S. domestic routes. They were to be 42-passenger aircraft in day configuration with sleeping accommodation for 30 and were to cost $300,000 (£60,000) each. The first DC-4 flew on February 14, 1942, but by then the United States had entered the war and the orders which had been placed were—after some hesitation—taken over by the United States Army Air Forces. The DC-4 went into military transport service as the C-54 during 1943 and the type soon proved invaluable for long-haul trans-ocean transport.

By the end of the war 1,163 of the military versions of the DC-4 had been built and the type was being used on a large scale to maintain the inter-continental communications of the Allies all over the world. Many C-54s were converted to civil use at the end of hostilities and a further 79 DC-4s were built as civil aircraft before the type was succeeded in production by the DC-6, a somewhat "stretched" and pressurized development (with a differential of 4.16 lb/sq in) which, after originally being projected as a military transport, first went into service with American Airlines on April 27, 1947. (Its first flight had been made on February 15, 1946). The DC-4 itself, although projected to have pressurization was, in fact, never so equipped and even the 300 still in service with the airlines today fly unpressurized.

The DC-6, as the first purely civil model of the DC-4 series, started a long line of airliner development which has included such successful aeroplanes as the DC-6B, DC-7B and DC-7C. A total of some 1,100 "post-DC-4" derivatives have now been built (850 for the airlines) and the later versions are still in large-scale production.

The structures of these aeroplanes have been logical and progressive developments of the DC-4. The DC-6 (wing loading: 55-64 lb/sq ft) and subsequent types have double instead of single-slotted flaps, raising the maximum achieved lift-coefficient from about 2.4 to about 2.6. The fuselage has been successively "stretched" in length to provide more capacity, more powerful engines have been installed and the fuel tankage has been increased. In the case of the DC-7C, the wing has also been extended by the addition of a new centre section, bringing the area up to 1,637 sq ft. The loaded weight has grown to 143,000 lb, but with all these developments, the airframe remains basically unchanged. It is primarily of 24S alloy although some of the later 75S alloy is also used, plus titanium in the latest models. The DC-7C marked another milestone to air transport development by being the first aeroplane to offer non-stop service with reasonable regularity on the Blue Riband London - New York route.

In April 1939, quite soon after it became clear that the DC-4E was to be dropped and Douglas started discussing the DC-4 with the airlines, Lockheeds also began preliminary work on a project in the same category to a specification issued by T.W.A. for a non-stop coast-to-coast aeroplane. A payload of 6,000 lb was required for a still-air range of 3,500 miles at a speed of more than 250 m.p.h. at 20,000ft.

Lockheeds, as we have seen, had been very successful in the years immediately before the war with their range of small transports which had been complementary to, rather than competitive with the DC-3. They had had a project in 1939 (the L.44 Excalibur) for a four-engined aeroplane of approximately DC-3 capacity. However, this was not developed. At about the same time, as a result of the discussions with T.W.A., they decided to compete directly with Boeing and Douglas in the long-range large aircraft category and their L.049 project, later named the Constellation, evolved closely similar in size to the DC-4. It had a wing span of 123ft and a wing area of 1,650 sq ft. The wing section was of N.A.C.A. 23 series, 18 per cent thick at the root but N.A.C.A. 4412 (12 per cent thick) at the tip. Fowler flaps gave an effective maximum lift coefficient of about 2.6. The gross weight was initially 68,000 lb and the wing loading 41 lb/sq ft.

"The DC-6, as the first purely civil model of the DC-4 series, started a long line of airliner development . . ."

Construction of the first Constellation started in 1940 to an initial order for nine aircraft from T.W.A., whose order was soon increased to 40 when Pan-American also ordered 40. The first flight was made on January 9, 1943. As with the DC-4, the Constellation was taken over by the military and put into service as the C-69. The first service flight with the U.S.A.A.F. was made on April 17, 1944, when a Constellation flew non-stop from Burbank to Washington in just over seven hours. However, the type did not go into full service until 1945, by which time 15 had been delivered. Airline operations started early in 1946. After a number of vicissitudes, which led to short-term groundings (also suffered by the DC-6), 135 were established in service by 1948.

Structurally, the Constellation's layout differed in detail from the DC-4 series, although the basic four-engined low-wing monoplane configuration with tricycle undercarriage was unchanged. The most obvious difference was that the Constellation had a circular-section "fish-shape" fuselage (of 132in maximum internal diameter), possibly suggested by the British de Havilland Albatross of 1937. The section provides space for two-and-two 22in seats on each side of a 24in aisle. The Constellation series is also frequently used with a five-abreast (two-and-three) high-density layout. The Constellation's attractive shape probably gives some small aerodynamic advantage and by "drooping" the front fuselage shortens the nosewheel leg. However, at the same time, it creates difficulties in the full use of the interior space. It is significant that the Douglas "parallel-section" formula has now been universally adopted for civil passenger transports. As already mentioned, the tail unit of the Constellation had triple vertical surfaces, in contrast to the single unit of the Douglas types. This also has now gone out of fashion. Lockheed's latest civil aeroplane, the new turboprop Electra, has both a parallel-section fuselage and a single fin and rudder.

This clear-cut adoption by Lockheed of design features which Douglas have shown to be more satisfactory is a good example of the far-sighted policy of American manufacturers—which has been particularly evident in their development of transport aircraft—of unhesitatingly changing over to design practices which competitor companies may have demonstrated to be superior to their own. This historical survey has given several instances, and there is no doubt that the practice has been an important reason for American leadership in airliner development. Equally evident is the reluctance of manufacturers in other countries—and, perhaps, particularly of the British—to adopt the same enlightened policy. Too often it appears that national pride, or a reluctance (or inability) to learn from other people's successes and mistakes, has led designers along unprofitable lines of development. The readiness of American manufacturers to adopt a design practice which one company has shown to have proven advantages is still very evident in their latest aircraft—as, for example, in their new jets. A high order of judgment is obviously required in weighing the case for adopting those innovations in design which are essential to progress against the conservative incorporation of proven features. One must hope that British manufacturers are now, at last, profiting from the lessons of the past 25 years.

But to return to the Constellation. This aircraft was of conventional construction in aluminium alloy and was, of course, pres-

TABLE III: CHARACTERISTICS OF THE FOUR-ENGINED "MODERN-TYPE" TRANSPORTS

Aircraft type	Engines	Take-off power (h.h.p.)	Maximum take-off weight (lb)	Wing area (sq ft)	Wing span (ft) (in)	Length (ft) (in)	Cruising speed (50% t.o. power) (m.p.h.)	Stalling speed (m.p.h.)	Type of flaps	Number of passenger seats
Junkers Ju 90 ...	4×B.M.W. 132H	4×850	50,600	1,980	114 10	86 3	160	68	Slotted	40
Focke-Wulf Fw 200	4×B.M.W. 132 G	4×720	32,120	1,291	108 3	78 2½	170	65	Split	26
Douglas DC-4E ...	4×P. & W. R-2180 ...	4×1,450	61,000	2,155	138 3	97 7	190	70	Slotted	42
Douglas DC-4 ...	4×P. & W. R-2000-3 ...	4×1,350	52,000	1,457	117 6	93 10	200	75	Slotted	42
Boeing 307 ...	4×Wright R-1820-G102A	4×1,100	42,000	1,486	107 3	74 4	200	70	Split	33
Boeing 307B ...	4×Wright R-1820-G105A	4×1,100	45,000	1,486	107 3	74 4	200	70	Slotted	33
Fairey F.C.1 ...	4×Bristol Taurus ...	4×1,040	45,200	1,300	105 0	76 0	210	66	Youngman	30
Lockheed L.049 ...	4×Wright R-3350-35 ...	4×2,200	82,000	1,650	123 0	94 11	280	77	Fowler	51

ORIGINS OF THE MODERN AIRLINER . . .

surized, the differential being 4½ lb/sq in. The wings had two main spars and a false spar carrying the ailerons and flaps. As with the DC-4, they incorporated integral fuel-tanks. The airframe of the Constellation has proved almost as suitable for repeated "stretching" as that of the DC-4. Indeed, the Lockheed type has been developed over the years since the war in parallel to, and in direct competition with, the Douglas family. "Pulling-out" of fuselage and wing has taken place, together with the installation of more powerful engines. Latest of the line is the L.1649A, which has a loaded weight of 156,000 lb and a new thinner wing, 1,850 sq ft in area and 150ft in span. Each Douglas development has been matched by a corresponding version of the Constellation and 850 have now been built, 500 for the airlines. The type is still in production, but the end of the line may now be near. The total development costs of the original Constellation have been estimated at $30,000,000 (£7,500,000), which gives some indication of the sharp increase in effort required to produce the larger and more complex four-engined equipment as compared with pre-war twin-engined types. The Constellation sold at $1,000,000 (£250,000) each in the immediate post-war years.

The DC-6 and the Constellation introduced some of the final refinements in the piston-engined transport aeroplane. These include power-boosted controls, pioneered on the DC-4E; the reversing propeller, which has greatly reduced runway over-running accidents and has eased the problem of operating from icy or slippery surfaces; and thermal de-icing of the leading edges of wing and tail surfaces. The reversing propeller was probably first demonstrated by Seth Hart in California on a D.H.4 in 1920. The American thermal de-icing systems resulted from work by the N.A.C.A. which started in 1927 and was tested with a trial installation in a Lockheed 12 from 1940. From the durability and maintenance aspects an important development has been the adoption of metal-covered control surfaces in the later versions of both Douglas and Lockheed types. Fabric covering for metal-structure control surfaces had previously been normal practice. Details of the four-engined designs which laid the foundations on which post-war air transport has been built are summarized in Table III. Table IV gives the more important dates in the development of these aircraft and an indication of the numbers which have been produced.

TABLE IV: THE FIRST FOUR-ENGINED "MODERN-TYPE" TRANSPORTS—DEVELOPMENT DATES AND NUMBERS BUILT

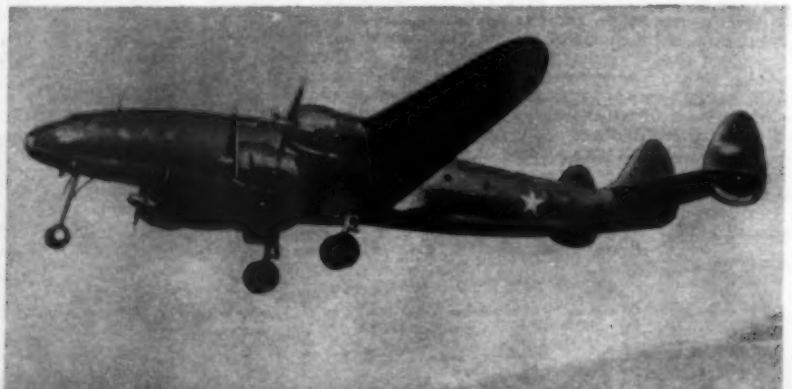
Aircraft type	Development dates			Approximate numbers built (including all transport derivatives)
	First thoughts	First flight	First airline service	
Junkers Ju 90 ...	Early 1936	7.6.37	Late 1938	†
Focke-Wulf Fw 200	Early 1936	6.9.37	Late 1938	†
Douglas DC-4E ...	Mid 1935	7.6.38	—	1
Boeing 307 ...	Mid 1936	31.12.38	Mid 1940	10
Fairey F.C.1 ...	Early 1938	Planned 1940	—	—
Douglas DC-4 ...	Mid 1939	14.2.42	Early 1943*	2,300
Lockheed L.049 ...	Mid 1939	9.1.43	Mid 1944*	850

* In military service. † Very few civil versions.

The derivatives of the DC-4 and L.049 and a small number of Boeing Stratocruisers, supported to a minor extent by some broadly similar types made outside the United States, have provided the backbone of the scheduled airlines long-haul equipment in the 1940s and 1950s. The Stratocruiser was developed by Boeing as a civil transport out of the B-29 and B-50 Superfortress bombers at the end of the war. Only 55 of the civil version were built but nearly 900 military KC-97 tanker-transports were supplied to the U.S.A.F. These long-haul aircraft have been supplemented on the shorter-hauls by the old DC-3 herself and by the Convair 240/440 series (1,100 built, 500 for the airlines) and, to a lesser extent, by the Martin 202/404 (about 150 built) and a number of non-American types. Douglas had projected, but not proceeded with, a development of the DC-3 in 1940 (to have been called the DC-6) which was closely similar in layout to the later Convair series.

All these aircraft have been described as being of the DC-4 generation. They certainly owe a great deal to that great aeroplane and—two generations further removed—to the Boeing 247 and DC-2. The 1950s have seen the appearance of the DC-4 type of configuration in its final form—with turboprop engines. The Vickers-Armstrongs Viscount—of which 375 have so far been ordered—has shown that the classic formula revitalized in this way has tremendous possibilities. Other aeroplanes—the Britannia, Electra, Vanguard and Il-18—are now following in its footsteps.

It is still difficult to assess the full future rôle of these types in the era of the subsonic jets which is now approaching. However, there is good reason to believe that, at any rate for shorter-haul air transport—which is certain to continue to interest the largest numbers of travellers—the turboprop aeroplane of the DC-4 formula will have a long and productive innings. The lower speed of the turboprop transport, as compared with the jet, may not prove to be a significant penalty on short stages and the greater operational and economic flexibility inherent in this type of power unit has strong attractions for these services. On longer-haul operations also, the turboprop aeroplane may yet emerge as the vehicle which is cheaper to operate than either piston-engined or jet types and which is therefore best suited to carry the great bulk of the lower-fare traffic. For the same reason, its potential in the freight market should be great. Time alone can show how long the turboprop aeroplane will remain a trunk-line type. We can at least be sure that many of the current piston-engined and turbine types to the classic formula will continue to carry much of the load on the world's air routes for many years yet. All this has grown out of the first flight of a small aeroplane of revolutionary design which took place at Boeing Field, Seattle, a quarter of a century ago.



"Construction of the first Constellation started in 1940 . . . the first flight was made on January 9, 1943."

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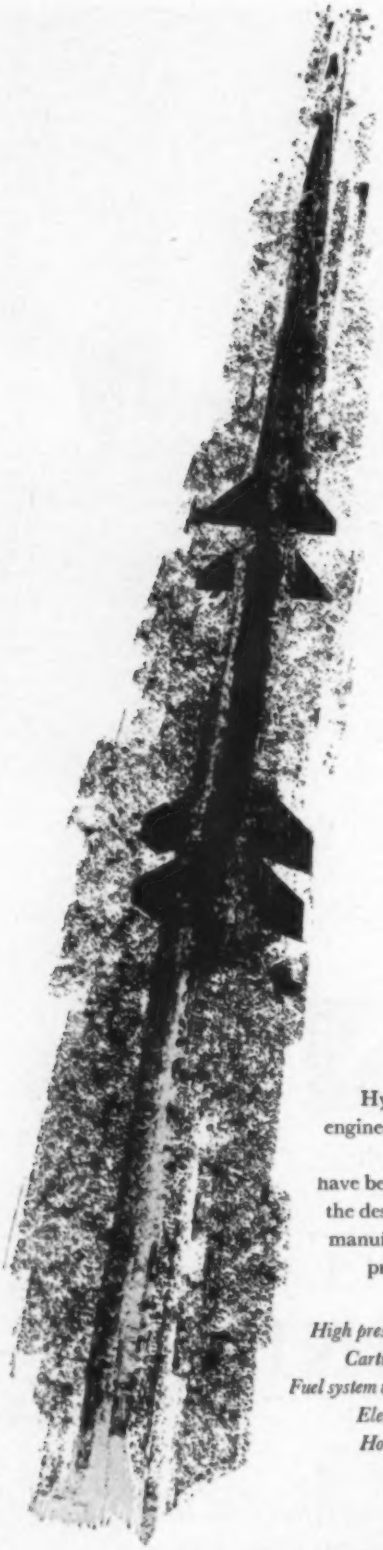

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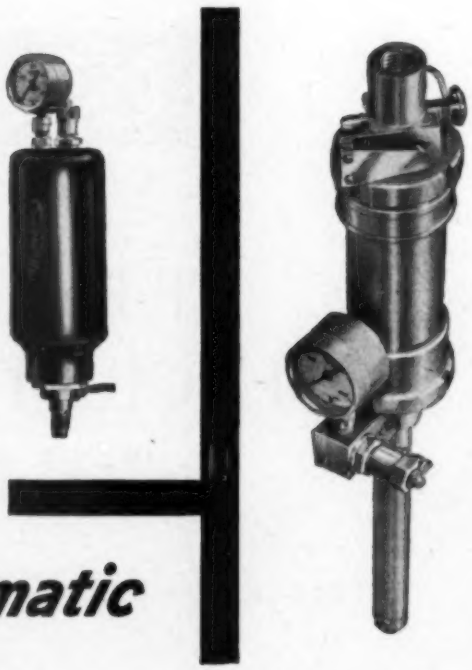

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There is no truth in the rumour that Air Ministry also considered making daggers optional for air vice-marshals and above.

● In the eyes of the law—to wit, the Air Corporations Act of 1949—the U.K. independent airlines can operate scheduled services only as "associates" of the Corporations. Upon the elasticity of the word association depends the future of the independents. Thus far its meaning has been stretched quite a lot—to the point where both Corporations feel that their traffic on certain routes is being materially diverted.

If this is true, then I suppose that some of the independents' scheduled activities make nonsense of the Act.

I began thinking along these lines when I saw Eagle Aviation's recent application to the Air Transport Advisory Council to operate the B.E.A.-monopolized London - Manchester route. If they are permitted to do so (and I think they will be able to show that the business is there) will they be "associates" of B.E.A.?

● Even in the aeronautical field one frequently finds that something one thought was new had, in fact, been done before. For example, I was recently trying to check whether or not the Convair XF-92 (Model 7002) really was the world's first delta-wing aeroplane. The farther back I went the more deltas I found; and I eventually turned up a beauty built in the summer of 1910 by Lange and Billard (not that I think that even this was the first).

Nevertheless, some achievements really are genuine firsts and deserve to be better remembered. There must have been a day when man first flew in an aeroplane (i.e., a heavier-than-air fixed-wing machine); but nobody can say for sure when it was. Many would suggest December 17, 1903 (even then they can never remember *which* of the Wright Brothers was at the controls); but a large—and increasing—number feel disposed to promote May 17 or July 20, 1882, when the Russian officer Alexander Mojaisky is alleged to have flown his steam-driven trimotor (which actually seems to have been completed two years later). Just to make the picture still more confused, Sir Hiram Maxim definitely flew his giant steam-driven machine in 1894 (but not in controlled "free" flight) and the U.S. government for many years always championed as the true first-flight pioneer Prof. Langley (pilot: S. F. Manley). All these people, and their achievements, have been written about *ad nauseam*; but I would still challenge anybody to get up and say, "I think Mr. X was the first man to fly, and I can prove it."

There are many more aeronautical dates of the first importance which few people can quote without research. Who, for example, was the first person to fly an aeroplane driven by any sort of jet reaction? Who was the first to fly a machine powered by any type of turbine? Who was the first to exceed Mach 1; what was the date and how fast did he go? Who was the first to fly a device capable of hovering on rotating wings (i.e., a helicopter)? I believe all these occasions are of such importance that next week I shall attempt to establish the facts.

● I hear that B.O.A.C. may decide to change their "Speedbird" call-sign because of its confusion with Seaboard's call-sign (which, oddly enough, is Seaboard). Apparently, according to one B.O.A.C. captain, confusion is greatest among Seaboard crews operating their own Super Connies on transatlantic freight charter to B.O.A.C. They just don't know whether to give the call-sign "Seaboid" or "Speedboid."

A candidate for B.O.A.C.'s new call-sign is Bo-line, which I hope would not be confused with their sister Corporation's Bea-line.

● Most of the larger aircraft companies are very careful to maintain books of press-cuttings. Canadair have actually produced a very handsome volume of selected clippings from all over the world dealing with their great Argus sub-hunter. *Flight*, I was glad to see, contributed much the largest cutting: seven pages from the October 4, 1957, issue. Thumbing through the Canadair book I idly began to count the number of times the common American misspelling "Brittania" occurred. Almost everybody seems to have noted the fact that the Argus was based on the Britannia, and the name was spelt correctly nearly 300 times. There were, however, 33 "Brittanias"—and, believe it or not, an encyclopædic "Britannica." The Bristol Britannica was launched by a newspaper in Toronto. It just shows you: if you want to sell something, call it by a number, like 707 or DC-8—then people will get it right.

Will they, though? I have just remembered that a British national daily had an article describing the recent roll-out at Long Beach of "the giant new jet DC-3."

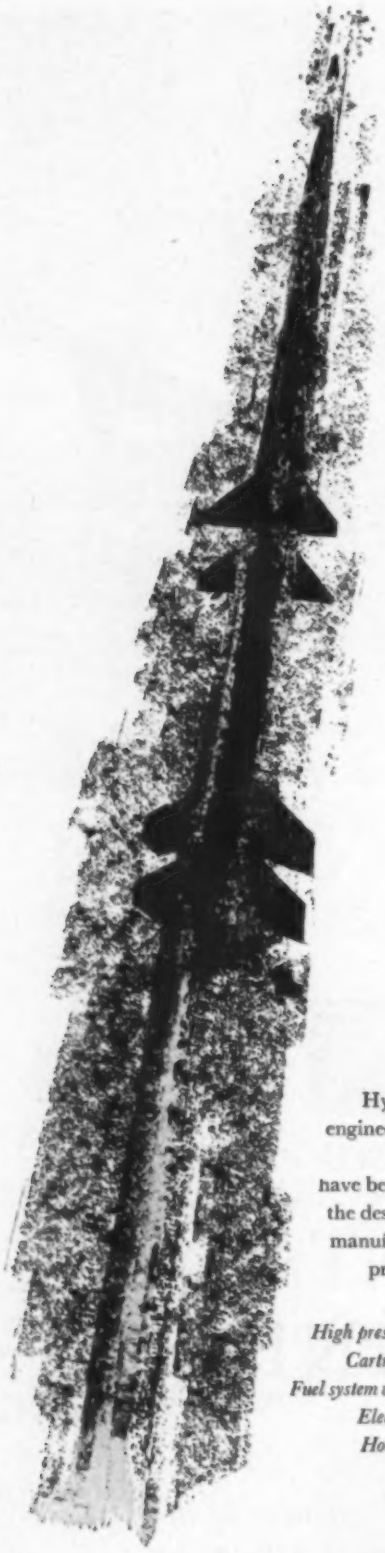
● According to the American *Aviation Daily* "Pentagon Policy regarding the release of the NATO code-names for Russian aircraft for some inexplicable reason is stricter than that of certain European countries." This seems just above the height of absurdity. I have already commented on the oddness of red-tape procedures which require that a code-name should be given when the real designation is known (why "Cleat," when it is really Tu-114?); but to keep the code-name itself secret suggests military minds loose on their hinges.

● One of the most difficult things to decide when designing a new transport is its size. Many orders have been lost because airlines have said: "Yes, that's fine, but it has a bit too much (or too little, or the wrong kind of) capacity."

He would be a clever manufacturer who could get round this one without stretching or contracting his fuselage. But wait: I think someone has done it. If ever you have wondered why A.W.A. went for twin booms on the 650, just take a look at the variety of payload containers they are offering to suspend between them.

ROGER BACON

● Wheeeh. . . . Wheeeh. . . . She's comin' down the track one hunnert ninety miles an hower. . . . Fresh out the deepo. . . . She's the tankinest, freightinest, plum locoest two-four-four this side the Rockies. *Man*, dig that *crazy* bogie. . . .



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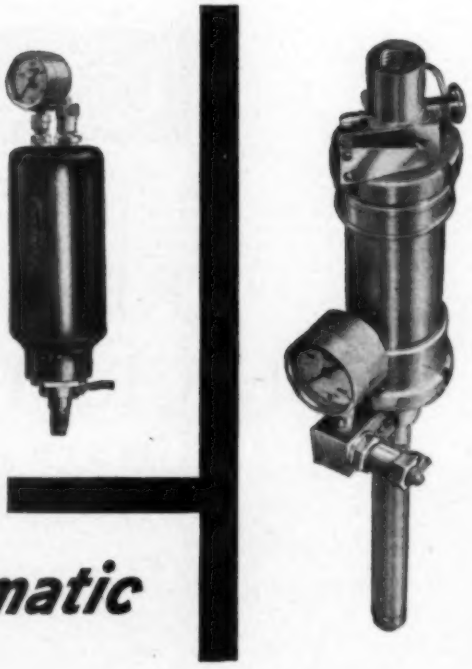

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I began thinking along these lines when I saw Eagle Aviation's recent application to the Air Transport Advisory Council to operate the B.E.A.-monopolized London - Manchester route. If they are permitted to do so (and I think they will be able to show that the business is there) will they be "associates" of B.E.A.?

● Even in the aeronautical field one frequently finds that something one thought was new had, in fact, been done before. For example, I was recently trying to check whether or not the Convair XF-92 (Model 7002) really was the world's first delta-wing aeroplane. The farther back I went the more deltas I found; and I eventually turned up a beauty built in the summer of 1910 by Lange and Billard (not that I think that even this was the first).

Nevertheless, some achievements really are genuine firsts and deserve to be better remembered. There must have been a day when man first flew in an aeroplane (i.e., a heavier-than-air fixed-wing machine); but nobody can say for sure when it was. Many would suggest December 17, 1903 (even then they can never remember *which* of the Wright Brothers was at the controls); but a large—and increasing—number feel disposed to promote May 17 or July 20, 1882, when the Russian officer Alexander Mojaisky is alleged to have flown his steam-driven trimotor (which actually seems to have been completed two years later). Just to make the picture still more confused, Sir Hiram Maxim definitely flew his giant steam-driven machine in 1894 (but not in controlled "free" flight) and the U.S. government for many years always championed as the true first-flight pioneer Prof. Langley (pilot: S. F. Manley). All these people, and their achievements, have been written about *ad nauseam*; but I would still challenge anybody to get up and say, "I think Mr. X was the first man to fly, and I can prove it."

There are many more aeronautical dates of the first importance which few people can quote without research. Who, for example, was the first person to fly an aeroplane driven by any sort of jet reaction? Who was the first to fly a machine powered by any type of turbine? Who was the first to exceed Mach 1; what was the date and how fast did he go? Who was the first to fly a device capable of hovering on rotating wings (i.e., a helicopter)? I believe all these occasions are of such importance that next week I shall attempt to establish the facts.

● I hear that B.O.A.C. may decide to change their "Speedbird" call-sign because of its confusion with Seaboard's call-sign (which, oddly enough, is Seaboard). Apparently, according to one B.O.A.C. captain, confusion is greatest among Seaboard crews operating their own Super Connies on transatlantic freight charter to B.O.A.C. They just don't know whether to give the call-sign "Seaboid" or "Speedboid."

A candidate for B.O.A.C.'s new call-sign is Bo-line, which I hope would not be confused with their sister Corporation's Bea-line.

● Most of the larger aircraft companies are very careful to maintain books of press-cuttings. Canadair have actually produced a very handsome volume of selected clippings from all over the world dealing with their great Argus sub-hunter. *Flight*, I was glad to see, contributed much the largest cutting: seven pages from the October 4, 1957, issue. Thumbing through the Canadair book I idly began to count the number of times the common American misspelling "Brittania" occurred. Almost everybody seems to have noted the fact that the Argus was based on the Britannia, and the name was spelt correctly nearly 300 times. There were, however, 33 "Brittanias"—and, believe it or not, an encyclopædic "Britannica." The Bristol Britannica was launched by a newspaper in Toronto. It just shows you: if you want to sell something, call it by a number, like 707 or DC-8—then people will get it right.

Will they, though? I have just remembered that a British national daily had an article describing the recent roll-out at Long Beach of "the giant new jet DC-3."

● According to the American *Aviation Daily* "Pentagon Policy regarding the release of the NATO code-names for Russian aircraft for some inexplicable reason is stricter than that of certain European countries." This seems just above the height of absurdity. I have already commented on the oddness of red-tape procedures which require that a code-name should be given when the real designation is known (why "Cleat," when it is really Tu-114?); but to keep the code-name itself secret suggests military minds loose on their hinges.

● One of the most difficult things to decide when designing a new transport is its size. Many orders have been lost because airlines have said: "Yes, that's fine, but it has a bit too much (or too little, or the wrong kind of) capacity."

He would be a clever manufacturer who could get round this one without stretching or contracting his fuselage. But wait: I think someone has done it. If ever you have wondered why A.W.A. went for twin booms on the 650, just take a look at the variety of payload containers they are offering to suspend between them.

ROGER BACON

● Wheeeh. . . . Wheeeh. . . . She's comin' down the track one hunnert ninety miles an hower. . . . Fresh out the deepo. . . . She's the tankinest, freightinest, plum locoest two-four-four this side the Rockies. *Man*, dig that *crazy* bogie. . . .

CORRESPONDENCE

The Editor of "Flight" is not necessarily in agreement with the views expressed by correspondents in these columns. The names and addresses of the writers, not for publication in detail, must in all cases accompany letters.

New British Two-seater

YOUR leading article in the May 9 issue, "Something for the middleman?" we find stimulating. You will probably be interested to know that the number of British companies making light aircraft has not been doubled, but trebled.

For your information, we are actively engaged with the design and manufacture of an economical side-by-side two-seater ultra-light aircraft. It is anticipated that the prototype will be flying before the end of the summer.

It is to be regretted, however, that there is not available a really suitable British-made power unit suitable for this class of aircraft.

Enfield, Middx. H. C. BURR, Director, Condesco, Ltd.

Fare Differentials

IF, as most authorities agree, turboprop propulsion offers potentially cheaper transport than pure jet, how can there be any question of permitting pure-jet vested interests, which hold the majority vote in I.A.T.A., to suppress the turboprop transport by refusing to concede a fare differential adequately reflecting its superior economics?

Is it not a matter for anger, alarm and amazement that not only our politicians but even British turboprop builders and operators appear, one and all, to be prepared supinely to accept, even in advance of its execution, a manœuvre which, apart from its blatant "big business" character, will deprive Britain of her present leading position in the field of turbine-engined transport aircraft and a substantial section of the world's population of the prospect of travel which the potentially cheaper fares of the turboprop would afford?

If I.A.T.A. should selfishly obstruct fare differentials between turboprop and pure-jet aircraft it will betray its trust and we should withdraw from it, whatever the inconvenience. Nor should we be satisfied with the concession of a measly 5 per cent [as proposed in "The Case for the Fare Differential," *Flight*, April 18 Ed.]. An option of up to 25 per cent is the least that should be accepted.

Failing agreement on these lines, the geographical position of Britain is such that we could rapidly make life intolerable for transatlantic pure-jet operators, e.g., by declining to lengthen airport runways and by inflicting swingeing penalties on any aircraft forced to land out of turn because of inadequate fuel reserves.

It is time we stood up for our rights and legitimate interests and cast off the timidity and subservience which seems to be stealthily laying hold on us. We shall be justly despised and our views disregarded if we do not, and we shall deserve our inevitable relegation to technical and economic oblivion.

Nicosia, Cyprus. TORQUEMADA.

Early Air-brakes

MAY I trespass on your valuable space to put a query regarding the Sopwith 1½-Strutter of 1916? This concerns the air-brakes fitted to that aeroplane and so adequately described in J. M. Bruce's recent outstanding book *British Aeroplanes 1914-1918*. Mr. Bruce omits any reference to the *use* made of these air-brakes and one is left with the impression that generally all pilots applied them when landing, as the makers obviously intended.

However, my own observations, although of rather limited scope, lead me to think that this was not so.

One Sunday in April 1916, I saw Harry Hawker arrive at Hendon from Brooklands on the prototype 1½-Strutter. After one or two fast circuits of the pylon course (see *Flight* photograph, April 20, 1916, page 327) Hawker came in low over the hangars, with the brakes "hard on," to land with a perfect three-pointer. Later in the afternoon, W/C. Busteed, then C.O. at R.N.A.S. Hendon, took this machine up for a trial trip, making a good landing with the brakes about half on.

I was drafted to R.N.A.S. Cranwell in the autumn of 1916 and found quite a number of 1½-Strutters attached to "E" Flight, and although I watched these machines over quite a long period I never saw one instance of these air-brakes being brought into use.

Will anyone who flew 1½-Strutters tell us whether he used these brakes and if not, why? Perhaps Capt. Norman Macmillan would oblige?

In conclusion I should like to express my thanks to *Flight* for continuing to foster the historical side of aviation, by allocating space for articles and correspondence.

London, S.W.7. ERIC J. ARNSBY.

House Full

IN *Flight* for May 2 you most generously gave us space announcing that the London Society's May 7 film evening at Caxton Hall. The item ended: "Visitors are welcomed."

Mr. D. V. Pettit, standing-in for Mr. W. E. Oliver, B.O.A.C.'s senior photographic officer (technical), arrived complete with projection equipment and "wide screen" for the showing of the novel aircrew training film *Hong Kong*. He also brought with him a crackerjack colour film, *Tomorrow is Theirs*, which showed the B.O.A.C. service build-up prior to a scheduled Britannia flight.

In view of the then three-day-old bus strike the hon. secretary hinted that the usual 100-plus potential audience might be reduced by as much as 50 per cent. But by 7 p.m. the "House Full" notice had to go up and some 25 latecomers be turned away. Although packed to "overload conditions" with a sort of U.E.C. (ultra economy class) seating arrangement in force, not one of the audience budged for the three-hour programme, which also included the new Westland film on helicopters and two U.S.A.F. films on Edwards and Wright A.F.B.s.

Remembering that *Flight* was the only weekly to mention this film show, and that the total membership of the London Society is less than one-tenth of Air-Britain's 1,000-strong membership, what is the answer?

Bear in mind that today most aeronautical organizations find it hard to muster an average turnout of 50 members, even for the best possible speakers. Bear in mind, too, the rival attractions of TV, etc. And salt the lot with a bus strike affecting all London and most of the Home Counties.

What is the answer? We would like to know how it should come about, this record 50 per cent increase in attendance, this virtual *embarras des richesses*? For, as I have not revealed before, we packed in 150 members and visitors!

Could the real answer be: the pulling power of *Flight*?

London, W.3. CHARLES W. CAIN, Hon. Secretary, London Society of Air-Britain.

Stand-in Britannia

ON page 647 of *Flight* for May 9 you show a photograph on which is a Britannia 102 which, it is claimed, brought from America the owners of the Triumph sports cars also shown on the photograph.

I can assure you that this Britannia did not bring anyone across the North Atlantic. The aircraft used was a Britannia 312, this aircraft not being available, apparently, when the cars and owners were ready for the photograph.

Stanwell, Middx. J. E. LIDIARD.

[The aircraft posed with the Triumph cars for the photograph was, in fact, Britannia 102 G-ANBA, and it was assumed that this was the aircraft which had been chartered—Ed.]

FORTHCOMING EVENTS

May 24-26. Belgian Aero Club: Brussels Exhibition Rally.
May 24-26. Fréjus-St. Raphaël Aero Club: Provence Wines Rally.
May 25-June 1. Aéro Club de l'Ouest: d'Angers Gliding Competition.
May 25-26. S.M.A.E.: National Model Contest, R.A.F. Waterbeach.
May 26. R.A.F.A.: Display, Hucknall.
May 26. Tiger Club: Sandown Race, I.o.W.
May 26-27. Canadian Aeronautical Institute: a.g.m., Toronto.
May 28. Kronfeld Club: "Cambridge University Gliding Club," by John Pringle.
May 29. The Royal Society: "The Institute of Aviation Medicine," by G/C. W. K. Stewart.
May 29-June 1. R.Ae.C.: International Invitation Rally, Shoreham.
June 1. Royal Belgian Aero Club: International Balloon Meeting.
June 1-3. Aéro Club de France: Helicopter Rally.
June 4. Kronfeld Club: Lecture by David Ince.
June 6. Helicopter Association: "Turbine Helicopters," by D. L. Hollis Williams.
June 7-8. Aéro Club de France: Normandy Rally.
June 7. Helicopter Association: Garden Party and Rally, Dunsborough Park, Ripley, Surrey.
June 8. Royal Dutch Aero Club: Balloon Trophy Competition, Rotterdam.
June 8. Wolverhampton Aero Club: Members' Competition Day.
June 14. Plymouth Aero Club: Air Display.
June 14-15. Popular Flying Association: Rally, Rhoose, Cardiff.
June 15-29. World Gliding Championships, Poland.
June 18. Kronfeld Club: "The Early Days," by F. N. Slingsby.
June 20-23. Lerida Aero Club: International Tour of Pyrenees.
June 20-23. Palermo Aero Club: Tour of Sicily.
June 21. R.N. Air Station Ford: At Home.
June 22. R.Ae.S.: Garden Party, White Waltham.
Sept. 1-7. S.B.A.C. Display and Exhibition, Farnborough.

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Helicopter Icing Research

SEVEN YEARS' WORK IN CANADA

WORK by the National Research Council of Canada in the field of helicopter icing was described by Mr. J. R. Stallabrass, of the Council's low-temperature laboratory, in a lecture to the Helicopter Association of Great Britain on Friday, May 9. The title of the paper was *Canadian Research in the Field of Helicopter Icing*.

After tracing the history of helicopter-icing work in Canada, which began at Edmonton in the winter of 1951-52 and was continued by means of two successive rigs at N.R.C., Ottawa, between 1954 and the present time, Mr. Stallabrass compared the present N.R.C. facility with similar ones at Mount Washington and Eglin A.F.B. in the United States. The Ottawa rig consists of a 75ft × 15ft frame, mounted on a 50ft mast and carrying 161 spray nozzles. The simulated icing cloud, in which the helicopter under test hovers in free flight, is formed of steam-atomized water-droplets.

Since the present Ottawa rig began operation in January 1955, the speaker revealed, tests had been carried out on Bell HTL-4, H-13H and 47G-2, Sikorsky H04S and Bristol Sycamore helicopters.

Mr. Stallabrass next dealt in turn with the effects of icing on helicopter performance and handling, methods of icing protection, requirements for a main rotor de-icing system, and controls. In conclusion, he said that Canada's flight-test work in this field had done much to indicate the nature of the icing problem and its serious aerodynamic and mechanical effects. It had shown that practical icing-protection systems for helicopters were possible and that the electro-thermal method held particular promise for success. By the end of 1960 helicopters should be entering service fully protected from the effects of icing.

The present helicopter-icing test rig at the National Research Council's Ottawa laboratories, with a Bell 47 undergoing trials. The icing cloud is produced by steam-atomized water droplets from the 161 spray nozzles of the mast-mounted frame.

FIREFIGHTERS FROM ALVIS

IN evolving the Salamander, their Mk VI crash/fire tender chassis, Alvis, Ltd., argued that if such a vehicle is to be effective at all it must be able to go directly to the scene of an accident, regardless of any mud, rocks or tree stumps that may be in the way. The conventional light commercial vehicle chassis loaded with the general paraphanalia of fire-fighting and rescue is suitable only for roads and runways; and a tracked vehicle, while excellent over rough country, has casual regard for runway lights and tends to be rather slow.

The suspension of the Salamander is virtually identical with that of the Alvis Saracen armoured personnel carrier—six wheels all independently suspended on wishbone links and sprung on long torsion bars. Each wheel unit is damped with a battery of shock absorbers and are all independently driven.

The chassis is a pontoon-type of structure which protects the suspension units over really rough going, and also provides some protection from temperature extremes; the inside can be heated, or cooled by air-ventilation. By interlinking the steering so that all four front wheels are driven, it is possible for the Salamander to continue to operate if it loses any one wheel, or any two wheels except the forward pair.

The result is a chassis of considerable robustness and a weight, for the complete vehicle, of around twelve tons. Nevertheless, the Salamander achieves a potent performance—a standing quarter-mile in 32.6 sec and a maximum governed speed of 50 m.p.h. —from its eight-cylinder in-line 6.5 litre Rolls-Royce engine. Each of the six wheels is driven through a pre-selector gearbox, a transfer box, shafting to each wheel and an epicyclic reduction gear in each hub.

During a recent visit to Coventry, *Flight* had the opportunity of sampling the Salamander's unusual form of suspension by driving an Armoured Command Post—with similar wheel and driving arrangements—over the Alvis test field. Both the Salamander and the Command Post chassis, the Saracen, can cross a trench five feet wide, surmount a verticle obstacle 18in high, cross a ford up to 2ft 6in deep or climb a 24 per cent gradient. What these figures do not convey is the extraordinary smoothness with which these manœuvres are performed. Firm but not harsh riding on the road is transformed to a wonderful smooth rolling ride on the great 14.00 × 20in tyres over hillocks and slopes.

The vehicle is not difficult to drive, and the steering is hydraulically power assisted (with proportional feel) but has manual reversion. Relatively little care is needed to pick the easiest path when driving over rough ground, but it is fairly important to select the right gear (there are five forward speeds) for the particular conditions.

Alvis have supplied about 80 Salamander chassis for service in various parts of the world, many of them for the Royal Air Force. The firm manufacture chassis only which go to Pyrene or Tecalemit to be fitted with bodies and special-purpose equipment. Alvis emphasize that, irrespective of the type of equipment fitted, the Salamander can arrive at the scene of an accident much more quickly than conventional crash trucks and this facility alone justifies the rather high cost of the complete vehicles (about £13,000). The finest fire-fighting equipment, Alvis suggest, justifies the best carrier that can be made.

Capable of a vigorous cross country performance, the Alvis Salamander crash-tender chassis (the suspension is similar to that of the Saracen armoured fighting vehicle) is designed to provide rapid access to an accident. The fire-fighting equipment illustrated is supplied by Pyrene.

Club and Gliding News

Bishop Tiger

TIGER MOTH G-APDZ, modified by Rollasons of Croydon for the Tiger Club and renamed after Mr. C. Nepean Bishop, is probably the only club aircraft in England which is capable of flying happily on its back under power for protracted periods. It is also highly "cleaned up" and very fast. Right way up, the Bishop cruises at over 80 kt at 1,900 r.p.m. and climbs 1,200ft in one minute. The other way up it cruises at 60 kt and gains height with ease. It is recommended that cross-countries be done right way up because map-reading the other way is rather perplexing and everything tends to fall out of the cockpit. During a 50-min flight last week I lost my map, and my headgear made an honest try to follow it down into Sussex. Since the Sutton harness lets one hang slightly high—or is it low?—in the cockpit, tight-fitting and airtight goggles are essential; but negative-g effects are surprisingly small.

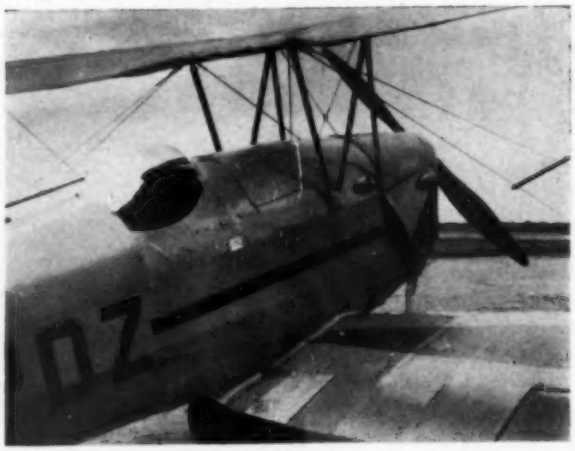
Main modifications to G-APDZ are the fitting of a Gipsy Major 1c giving about 138 h.p., a Fairey Reed metal propeller, an inverted float chamber and injection device and an extra oil pump in the crankcase to allow continuous inverted flight. The centre-section of the upper wing is now a thin fairing, a 10-gal fuel tank with special stack-pipe arrangement being located in the forward cockpit space. The front cockpit itself has been faired by a detachable panel and holds only equipment. All gaps have been sealed or faired and the airframe is covered in light-weight fabric. The anti-spin strakes have been removed and the elevators extended aft by a few inches. Aileron gearing has been altered slightly. The walkways on the wing-roots have been replaced by a single small tread-board to starboard, the cockpit side-doors have been permanently closed and the windscreen reduced to a small curved plastic shield. The slots have been eliminated. The new empty weight of 1,118 lb is remarkably low. Gross is 1,825 lb.

The inverted fuel supply has to be selected according to an unnatural but straightforward procedure. Main fuel is turned off and a selector switched over. After some seconds of rough running the normal float chamber empties and the engine cuts. Then the fuel supply is restored, this time to the inverted float chamber, and the engine picks up again. Normally about 45 min (5 gal) of inverted flying is possible, though during my flight the engine cut while I was inverted after about 35 min.

During some preliminary straightforward aerobatics I found the Bishop had a poor rate of roll. Elevator control was good in normal attitudes, but towards the top of a loop I found I had to increase the pull sharply to keep in the loop and avoid launching off into a sustained near-inverted climb. When first I remained inverted I found a similar tendency and trimmed back to avoid climbing. Upside-down at about 45-50 kt after a half loop lateral stability was poor, as might be expected, and the stick had to be held right forward. But if rolled over at about 80 kt, the Bishop flew well. Lateral stability was still poor, but the elevators remained in a normal position and pitching control was adequate. I had to coax it into a turn, again noticing a sharp elevator trim-change as the turn developed; and then loss of aileron effectiveness ensued, followed by apparent slight aileron reversal. I blamed my rudder control and continued to practice, using several degrees and directions of rudder. Its effectiveness appeared negligible and, after a certain bank angle, apparent aileron-reversal was repeated.

During this time I was myself getting used to flying inverted, since this is vastly different from the momentary inversion one experiences during normal aerobatics. While inverted I also found some difficulty in orienting myself relative to the ground, and I only succeeded in achieving an approximate heading for base after about one minute inverted. The compass was, of course, useless, and the sun was not very strong. Visibility towards the ground was also restricted by ill-fitting goggles which I had to hold in place with the disengaged hand. This was when I lost my map.

But inverted cross-country flying is hardly the Bishop's job. For aerobatics it has the great advantage of excellent climb and all-altitude power, but a rather poor rate of roll. Its aerobatic capabilities are otherwise no better than those of the normal Tiger, since it is not additionally stressed for flick or high-negative-g manœuvres. For racing it should prove, initially at least, the handicappers' dilemma and a very fast runner. C. M. L.



"Flight" photograph

The Bishop features a faired front cockpit (containing a 10-gal fuel tank) and a revised upper-wing centre-section.

A TALK by Dan Smith on the 1954 Eastern European Gliding Championships at Leszno Airfield, Poland, was illustrated at the Kronfeld Club on Wednesday, May 14, by an excellent colour film taken at the contest. Leszno is to be the scene of next month's World Gliding Championships. Among those present at the Kronfeld Club on last week's occasion were Eric Burdett, Don Brown and Keith Wakeman—who will respectively represent Central Africa, Australia and New Zealand at the world championships.

FAIR OAKS Aero Club's full fleet of 14 aircraft are expected to be flown to Antwerp on the occasion of a club visit this coming weekend (May 24-26). The club's air display this year will be held on July 19 or 20.

UNTIL recently a holding company for Cheltenham Aero Club, Club Aviation (Cheltenham), Ltd., is now responsible for maintaining the aircraft of both this club and the Cotswold Aero Club. The management of Staverton Aerodrome, Cheltenham, has recently changed from Cambrian Airways to Smiths Aircraft Instruments, and, as this latter firm operates the aerodrome only during weekdays, Cheltenham Aero Club is now handling ground-control and emergency services during evenings and weekends. This responsibility includes maintaining the aerodrome fire-engine at readiness. Two forthcoming events at Staverton are the Cheltenham club's tea patrol on May 24, and an air display on June 28.

This year's International Rally at Jersey, reported briefly last week, was a notable success. Among the programme attractions were a Vin d'Honneur given by the parish at St. Helier, and a dinner-dance at Jersey's Portelet Hotel. The rally winner for the third time was H. B. Showell, whose Aiglet (seen, below right, being judged) was runner-up in the Concours d'Elegance. Below left, the Nord Norécrin 2 of M. Lalonne of the Normandy Aero Club, winner of the arrival-time competition.

SERVICE AVIATION

Royal Air Force and Naval Flying News

Capt. C. P. Coke, commander of H.M.S. "Victorious," at a dinner given recently aboard the carrier to firms who made presentations to the wardroom mess. He is seen with the Hon. Edmund Ironside and Mr. S. E. Clarke of the radar division of Marconi's Wireless Telegraph Co., Ltd., who made a gift of a set of twenty silver ashtrays.

Minot Trophy

FOUR B-52s of the U.S.A.F. 92nd Bomb Wing, operating from Brize Norton, have been participating with Vulcans and Valiants of R.A.F. Bomber Command in this year's competition for the Laurence Minot Trophy. It began on May 14 and was due to end last Tuesday; each of the eight R.A.F. squadrons competing was represented by four aircraft, the contest being for accuracy in navigation to and bombing of targets reached by different routes of approximately 1,800 n.m.

R.C.A.F. Changes

FOLLOWING the appointment of A.V-M. C. R. Dunlap as Deputy Chief of Staff, Operations, at SHAPE [as announced on this page last week] he is to be succeeded as R.C.A.F. Vice-Chief of Air Staff by A.V-M. D. M. Smith. A.V-M. Dunlap takes over his new post on June 15 with the acting rank of air marshal; A.V-M. Smith becomes V.C.A.S. on June 20 and he will be succeeded as chairman of the Canadian Joint Staff in London by Maj-Gen. G. Kitching.

Worthwhile Journey

EXCELLENT performances were put up by the Comet 2 of No. 216 Sqn. —carrying the Secretary of State for Air— and the two Vulcans of No. 83 Sqn. which went to South America recently to take part in the inauguration ceremonies of Dr. Arturo Frondisi as the new Argentine president. All three aircraft, which were accompanied by two Hastings of No. 24 (Commonwealth) Sqn., carrying ground crews and spares, bettered their scheduled times on almost every leg, and on the return journey improved on their outward times. The Vulcans flew from Rio de Janeiro to Dakar—approximately 2,761 n.m. —in 6 hr at 556 m.p.h. and from Dakar to Waddington in under five hours.

When the Secretary of State for Air reached Lyneham, he said that the 100 per cent serviceability, punctuality and high performance of the Vulcans and Comet created a very fine impression and had done much to enhance the reputation of the British aircraft industry. Details of the Vulcans' performance have been sent by the force commander, A.V-M. G. A. Walker, A.O.C. No. 1 Group, to Mr. J. A. R. Kay, general manager of A. V. Roe and Co., Ltd.

Radio-Warfare Venoms

NO. 831 Squadron, Fleet Air Arm, was re-commissioned at R.N.A.S. Culdrose early this month (after being disbanded late last year), re-forming from No. 751 Sqn. and coming under the command of the latter's C.O., Lt-Cdr. W. J. Hanks. Equipped with Sea Venoms and Avengers, it is employed in the electronic warfare rôle [This is the first official indication that aircraft faster than Avengers are being used for this function.]

No. 831 Sqn. was first formed in 1941 as an A.S. unit, equipped with Albacores. One of its outstanding wartime exploits was the attack on *Tirpitz* in Kaa Fjord. After serving in the Far East, the squadron was disbanded in December 1944 then re-formed at R.N.A.S. Ford in 1955 with Wyverns, being disbanded again in December 1957.

The squadron from which it has now been re-formed started at R.A.F. Watton in 1950 as a Naval Development Unit, becoming No. 751 Sqn. in December 1951. Its task in early days was the evaluation and development of new equipment, and this still continues, together with demonstrating the capabilities of equipment to the Fleet and training establishments and taking part in annual air defence exercises. Since last year, however, the squadron has been detaching groups of aircraft to carriers. Its new number—assumed from May 1—indicates that it now has front-line status.

Alastrean House Re-opened

WITH the recent re-opening of Alastrean House on Royal Deeside by A.V-M. P. D. Cracroft, senior R.A.F. Officer Scotland, the R.A.F. once again has a leave centre in Scotland for its officers and for Commonwealth Air Force officers.

Alastrean House, the country home at Tarland of the late Lady MacRobert, was first opened as a leave centre in 1943. It was destroyed by fire in 1952 and has since been rebuilt at a cost of £30,000 by the MacRobert Trust Estates.

Lady MacRobert, who died in 1954, lost her eldest son in an aircraft accident in 1938 and her two other sons on R.A.F. operations during 1941. In that year, she gave £25,000 for the purchase of a Stirling, to be called *MacRobert's Reply*; and she later donated £20,000 for four Hurricanes

S/L. G. Alderdice, who during the war flew one of the MacRobert Hurricanes, with his wife at Alastrean House when it was reopened recently as a leave centre (see item above).

—each bearing the MacRobert badge and three of them the names of her sons—for service in the Middle East.

Reid Trophy Victors

DURHAM U.A.S. won the Reid Trophy —which they compete for annually with the Leeds, Hull and Nottingham squadrons—at R.A.F. Rufforth on May 11. The contest includes navigation, aerobatics and spot landings and Durham gained ten points against eight scored jointly by Nottingham (the holders) and Hull and four by Leeds. Mrs. H. V. Satterly, wife of the A.O.C. of No. 64 Group, presented the trophy to S/L. K. R. Richardson, C.O. of the Durham squadron.

R.A.F.A. Chairmanship

CHAIRMAN of the national council of the R.A.F.A. since 1945, Air Marshal Sir Robert Saundby is not standing for re-election at the Association's annual conference in Edinburgh (May 31-June 1). But since his term of office has been of such great value, the council has unanimously agreed that on his retirement he should be invited to become an honorary vice-president, so that his advice and help will still be available. Air Marshal Sir Harold Lydford, president of the Scottish area from March 1951 to March 1953, has been nominated to succeed Sir Robert as chairman.

Gosport Commemoration

A MEMORIAL is to be unveiled at Gosport Airfield next Wednesday (May 28) by Air Chief Marshal Sir Arthur Longmore, who commanded R.N.A.S. squadrons there in 1914, to mark its closure and to commemorate its historic ties with Service aviation.

Gosport was one of the first five airfields chosen for the R.F.C. in 1912. Three years after the first R.N.A.S. squadrons had been based there an R.F.C. School of Special Flying (later to become the R.A.F. Central Flying School) was formed, and it was this that brought Gosport its greatest fame. For the method of training devised by Lt-Col. (later W/C.) Smith Barry, with the pupil sitting in the front cockpit throughout his training and listening to the instructor's patter via a "Gosport tube," became universally adopted as the Gosport system.

Gosport was taken over by the Royal Navy from the R.A.F. in 1945 and since then, as H.M.S. *Sultan*, its primary function has been the training of helicopter pilots. The memorial which Sir Arthur Longmore is to unveil consists of a stone plinth bearing a plaque and surmounted by a globe and a bronze eagle. It is the work of Mr. N. Churcher of Gosport.

Brussels Heliport in the morning. Sabena's Vertol 44 is about to taxi to take-off point on the morning service to Lille. Note the International Fair symbol on the forward fuselage.

CIVIL AVIATION

THE MOST IMPORTANT ROUTE

NO route carries more air traffic than that linking North America and Europe. Last year just over one million passengers were flown across the North Atlantic, a total only fractionally less than that carried by the shipping lines. This movement represents 8 per cent of global air traffic, or 15 per cent if internal U.S. traffic is excluded. The importance of the route to European airlines is shown by the fact that their share of North Atlantic traffic amounted to one-fifth of the total traffic carried by *all* European carriers, and one-third of that lifted by the eleven European carriers which fly the North Atlantic.

In value terms, airlines probably received total revenues of about £110m ($310m) on last year's North Atlantic operations. This was split evenly between the five North American operators on the one hand (three U.S., two Canadian) and eleven European airlines (including one non-I.A.T.A. member) on the other. The hard currency earned by the latter group was almost certainly in excess of $100m.

The number of passengers travelling on scheduled services reached 1,013,000, an increase of 23 per cent over the 1956 figure. Except for 1952—when traffic rose by 30 per cent with the introduction of tourist-class services—no year has ever shown such a sharp rate of growth. The main factor behind last year's experience was the cheap westbound emigrant fare which had come into effect in the last months of 1956. This was evident from the fact that westbound traffic in the first six months of last year increased by 53 per cent over that for the corresponding period in 1956, and also from a rise in the gap between annual westbound and eastbound traffic from about 30,000 passengers in the years before 1956 to 115,000 in 1957.

Although the stimulus of emigrant fares pushed up the annual volume of tourist-class traffic by 29 per cent, first-class traffic continued the trend set in recent years by an increase of 9 per cent. First- and tourist-class traffic moved in the proportion 1:3.

Another continuing trend was the increasing importance of mixed-class travel. The number of first-class flights was cut sharply from 4,050 in 1956 to 3,121 in 1957, continuing the downward trend set since reaching a peak of 10,685 in 1951. Tourist-class flights reached a peak of 7,628 in 1954 and have since fallen steadily to 6,999 last year. The number of mixed-class services, by contrast, has increased rapidly since their introduction in 1952, and last year reached 14,203.

With the single exception of 1952 (when the volume of newly created tourist traffic ran ahead of available capacity) last year's load factors were the best ever experienced. The overall average for 1957 stood at 67 per cent, the eastbound load factor being 59 per cent (a typical figure for recent years), but the westbound factor reached the remarkable figure of 74 per cent. Taking load factors for each separate class of traffic, the eastbound factor was 59 per cent in each case. Westbound factors were higher, with first-class traffic showing 63 per cent, and tourist-class reaching an unprecedented 78 per cent.

These averages conceal wide differences between individual airlines. T.C.A. has, in recent years, continued to show the highest load factors of any North Atlantic airline. This carrier has achieved an average between 75 and 80 per cent for each of the last six years: no other airline has reached 75 per cent in any one year. B.O.A.C., Air France and Swissair each experienced load factors slightly over 70 per cent, B.O.A.C.'s performance in particular being an improvement over previous years. Most carriers lay in the 65-70 per cent category. In the past, particularly poor load factors have consistently been shown by four operators—El Al, Iberia, L.A.I. (now Alitalia), and Sabena. El Al and Sabena improved their position last year, reaching 59 and 61 per cent respectively, but Iberia and L.A.I. were still selling less than half their seats.

If there is a general rule, it is that the lower the frequency the lower the load factor, particularly if there is little access to emigrant traffic.

In carrying over a quarter of a million passengers across the North Atlantic last year, Pan American continued to hold their place as major airline on this route. Their share of total traffic reached a peak of 28 per cent in 1955, but has since declined to 26 per cent. T.W.A. obtained 21 per cent of traffic in 1954, but its share has since fallen rapidly each year, dropping down to 15 per cent last year. B.O.A.C. carried its largest share in 1953 (15 per cent) but the following year its traffic fell sharply and has subsequently remained at a steady 11 per cent. Since 1950 PanAm, T.W.A. and B.O.A.C. have held the top three places across the North Atlantic, and together account for just over one-half the total traffic. (This share has fallen steadily from two-thirds prior to the introduction of tourist-class fares.) Following these leaders come three other carriers—S.A.S., K.L.M. and Air France—that are constantly jostling for position but which together account for a steady quarter of North Atlantic traffic. K.L.M. has since 1950 headed this group, but was last year overtaken by S.A.S., each carrying 9 per cent. Air France has in recent years carried a steady 8 per cent.

The remaining smaller carriers have been steadily increasing their share, not apparently at the expense of S.A.S., K.L.M. and Air France, but to the detriment of the three leaders. This increase has not come from a growth in the proportion of traffic carried by the three carriers originally constituting this group—T.C.A., Sabena and Swissair have respectively carried 5, 4 and 3 per cent for a number of years—but from the entrance of new airlines to the North Atlantic. Lufthansa, Loftleidir and Canadian Pacific are the fastest-growing of these (respectively carrying 4, 3 and 2 per cent of traffic last year), while Alitalia/L.A.I., El Al and Iberia have remained fairly static, each carrying about 1 per cent. The sixteenth scheduled North Atlantic

Now touring South America is this Fokker Friendship, seen taking off from Schiphol fitted for the first time with its new pylon fuel tanks.

'So this is a Nine-g structure...

but how about Economic Strength?'

The airline accountant has his own standards of judging an aircraft. From the financial point of view, two features of the Viscount 810/840 are outstanding. It is 50% cheaper than any other four-engined turbo-prop, and seat mile costs will be even lower than earlier Viscounts.

With this low first cost and economy in service goes the passenger appeal which keeps load factors high and ensures profitable operation. The new Viscount 810 already has a cruising speed of 365 m.p.h. The changeover to more powerful Rolls-Royce engines in 1960 will give 400 m.p.h. cruising.

The success of Viscounts is based on two important facts. Passengers prefer them—and they produce healthy airline balance sheets.

VICKERS VISCOUNT 810/840

FOUR ROLLS-ROYCE DART PROPELLER-TURBINE ENGINES

VICKERS-ARMSTRONGS (AIRCRAFT) LIMITED WEYBRIDGE SURREY

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into this space fits the smallest in the range of the world's finest blowers

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A blower as small as this one and able to move 20 c.f.m. at 1.7" s.w.g. is, you'll admit, something out of the ordinary run. It is super efficiency in a small way and Plannair's contribution to Design Engineers for the lightweight solving of heat dissipation problems. Right through the range, Plannair Blowers and Wafters are, on a size/air movement capacity basis, the finest in the world for all contemporary heating, cooling and ventilation applications. May we send you details?

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PLAI3

CIVIL AVIATION . . .

airline, Seaboard and Western, concentrates on freight services. A seventeenth carrier, Aerlinte (Irish Air Lines), started operating only in the spring of this year.

The share of North Atlantic passenger-traffic borne by North American carriers last year fell for the first time below one-half. Prior to 1953 their share had fallen steadily to 50 per cent, but PanAm's success in the tourist field (with the DC-7) saw the North American airlines' share rise to 54 per cent in 1955; it has subsequently fallen again, dropping to 49 per cent last year.

Volumes of transatlantic freight and mail continued to grow last year, annual increases being recorded of 18 and 10 per cent respectively. The volume of eastbound freight grew particularly rapidly (28 per cent) as Seaboard and Western moved into full operation. The flow of freight is predominantly westbound (this has been the case since 1949, when devaluation of most European currencies in terms of dollars opened up the American market to quality European merchandise) but a few airlines such as Air France and B.O.A.C. manage to pick up more freight in North America than in Europe.

At 10,000 tons, the amount of airmail crossing the Atlantic is just half that of air freight. Although total mail traffic is fairly evenly balanced in either direction, for each individual airline the volume of outbound mail is always several times greater than the inbound movement. T.W.A. is unique insofar as it carries considerably more mail than freight. This carrier also enjoys the highest average mail load per flight (two-thirds of a ton), B.O.A.C., Lufthansa, PanAm and T.C.A. each average a half-ton mail load.

JAPAN'S NEW AIRLINER PROJECT

EARLIER this year it was reported that a consortium of Japanese manufacturers was considering the design of a medium-sized turboprop for Japan Air Lines' domestic routes. Details of the project have since been awaited with interest, particularly as this is post-war Japan's first venture into the civil transport market and a first full-scale experiment into the possibilities of joint design and manufacture by the major firms of one nation's aircraft industry. Six manufacturers are taking part—among them Mitsubishi, Kawasaki, Fuji and Showa—and the design committee includes representatives of J.A.L. A photograph of a model of the proposed design was published in *Flight* of March 7.

The general arrangement drawing and table reproduced on this page show the aircraft—it is as yet unnamed, although "A" and "B" versions are contemplated—to be a twin-engined turboprop of conventional appearance. The drawing and data represent the conclusions of the committee as given in the Japanese magazine *Aireview* by Mr. S. Kikuhara, one of the designers. The committee set out to design an aircraft with 50-60 seats and a range of about 1,000 miles that would be able to operate from Japan's limited—and largely inextensible—runways, but a slightly larger aircraft was also considered as a means of fulfilling J.A.L.'s longer-term needs for a transport for use in South-East Asia.

As no suitable 1,500 h.p. engine was available for a four-engined layout, two Darts (two Tynes for the heavier aircraft) were chosen on grounds of reliability and long life. Similar considerations affected the choice of wing position, and a low wing was adopted because of the facility it offers for easier maintenance, particularly of the engine and flap controls. In order to provide the necessary short field performance, double-slotted flaps extending across 80 per cent of the span have been adopted, and the rather short ailerons are supplemented by long differential-action spoilers immediately ahead of the flaps. Blown flaps are envisaged as a later development. The wing is unusually thin; the t/c ratio on the "A" version is 14 per cent at the root and 12 per cent at the tip, and the "B" wing promises to be even thinner.

According to Mr. Kikuhara, a prototype should be flying within two years.

JAPANESE TURBOPROP AIRLINER PROJECT

	Version A	Version B
Span	92ft 9¼in	92ft 9¼in
Length	85ft 3½in	86ft 11in
Wing area	861 sq ft	861 sq ft
Aspect ratio	10	10
Powerplant	Dart RDa.10	Rolls-Royce Tyne
Power assumed	2,660 e.h.p. × 2	4,695 e.h.p. × 2
Gross weight	43,000 lb	55,500 lb
Seating capacity	50-60	60-70
Wing loading	50 lb/sq ft	62 lb/sq ft
Power loading	8.1 (lb/e.h.p.)	5.9 (lb/e.h.p.)
Cruising speed (at 20,000ft)	320-340 m.p.h.	415-430 m.p.h.
I.C.A.O. field length	3,940ft	3,940ft
* Range with 50 passengers	1,000 st. miles	—
* Range with 60 passengers	500 st. miles	1,000 st. miles
* Range with 70 passengers	—	600 st. miles

* With 230 st. miles diversion, 45 min stand off and 5 per cent reserve.

THREE AIRLINE ACCIDENTS

THREE airlines, Sabena, P.I.A. and B.E.A., suffered accidents last weekend. Most tragic, in terms of numbers of casualties, was the loss of a Sabena DC-7C, OO-SFA, at Casablanca on May 19. The aircraft overshot the runway and caught fire; of the 69 people on board, only four passengers—all in the rear fuselage—survived.

On May 15 a Pakistan International Convair crashed while taking off from New Delhi. Twenty of the 32 occupants lost their lives, among them Capt. J. R. Steer, B.O.A.C.'s sales manager, N.E. Asia, who was based at Hong Kong. On the following day, a Pionair Leopard of B.E.A., registration G-AGHP, crashed in a storm at Nemours, near Paris. None of the crew of three survived. This accident increases the disturbing total of B.E.A. write-offs in the past eight months to six: a Heron (28.9.57), three Viscount 802s (23.10.57, 17.11.57, 28.4.58), an Elizabethan (6.2.58) and a DC-3 (16.5.58).

FLOUTING I.A.T.A.'s FARE-STRUCTURE

IT is generally accepted that all scheduled international airlines, whether they are members of the International Air Transport Association or not, charge I.A.T.A. fares on international routes. If an international non-I.A.T.A. airline operating services into another country cuts its fares below those prescribed by I.A.T.A., then the country concerned—if the interests of one of its own carriers is affected—can withdraw the traffic rights of the offending foreign carrier.

Thus it is that I.A.T.A.'s fares are enforced by the traffic-rights sanction which governments can always exert. This has never happened. Indeed, the very few occasions on which governments have withdrawn the traffic rights of a foreign carrier have been as a consequence of political animosities.

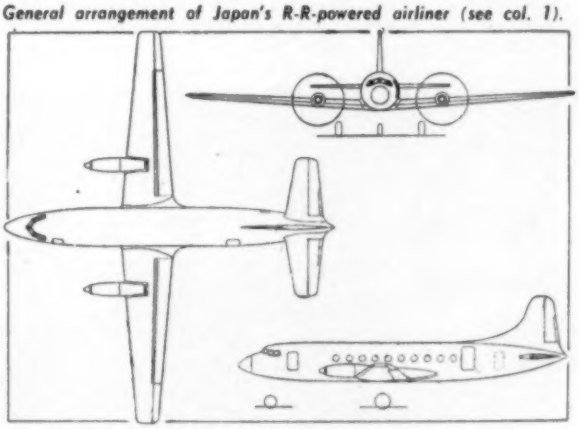
There is, of course, one well-known exception to the I.A.T.A. fare structure: Loftleidir's slow and relatively "uncomfortable" DC-4 service between Europe and America. This is accepted by the sixteen other North Atlantic carriers, not just because it is on a small scale (three per cent of total traffic) and not particularly competitive, but because it is accepted by the American C.A.B.

But there is another exception, and on a much wider scale. Those who have ever wondered at the effect of open-rate air transport warfare need only look at some of the services between the U.S.A. and Latin America. PanAm, Pan American-Grace and Braniff, all I.A.T.A. carriers (the first two having pioneered U.S.-Latin American air services and dominated them for nearly 30 years), are being deeply undercut by half-a-dozen or more non-I.A.T.A. carriers of Latin American nationality. Though traffic figures are not available, it is certain that all three U.S. carriers are losing business—though probably not on anything like the scale suggested in the American Press—to their cut-rate competitors.

It has been reported in *American Aviation* that the "extraordinary situation in which cut-price non-I.A.T.A. carriers are winning traffic from the established I.A.T.A. carriers may have dire consequences [i.e. airline subsidies] for the U.S. taxpayer." And *Time* magazine also suggests that PanAm, Braniff and Panagra may have to appeal for subsidies. This may be describing the situation too strongly: but there is no doubt that stiff competition is being felt.

The situation is confused, but from the *ABC World Airways Guide* it is possible to compare the fares offered to and from Miami by such airlines as Compañia Ecuatoriana de Aviaçion, using C-46s; Aerolineas Peruanas, C-46; TAN (Honduras), C-46; and Aviateca (Guatemala), DC-4. The American I.A.T.A. carriers affected are Panagra and PanAm, using DC-6Bs, and Braniff, using DC-6s and DC-7Cs. Details are in the table overleaf.

General arrangement of Japan's R-R-powered airliner (see col. 1).



CIVIL AVIATION . . .

From Miami to	Cut-price Fare	I.A.T.A. Fare (Tourist)
Panama City	$55	$94
Santiago	$210	$484
Guayaquil	$110	$194
Lima	$150	$262
Guatemala City ...	$55	$82
Buenos Aires	$251	$412

Operating from Santiago to New York is the Chilean operator CINTA, whose DC-4s—described as "Super DC-4Bs"—are styled to look like Panagra's DC-6Bs (with their round windows painted to look square, and with the same colour scheme). One service is called "El Latinamericano," the similarity to Panagra's "El Interamericano" being too close for coincidence. Comparable tourist fares are $280 CINTA and $412 Panagra. Another airline, Chile's ALA, also competes with Panagra between Santiago and Central America using DC-4s styled to look like the U.S. carrier's DC-6Bs.

How does this state of affairs exist in an international air transport system which generally accepts and abides by the I.A.T.A. fixed-fare structure? The answer is to be found in the three initials C.A.B. The American Civil Aeronautics Board cannot regulate international air transport; but it does not automatically protect its national carriers by forbidding entry to competitors which, because of their lower costs, can offer lower fares. This is a fascinating situation; it is not the Latin American carriers who are defying I.A.T.A., but the C.A.B.

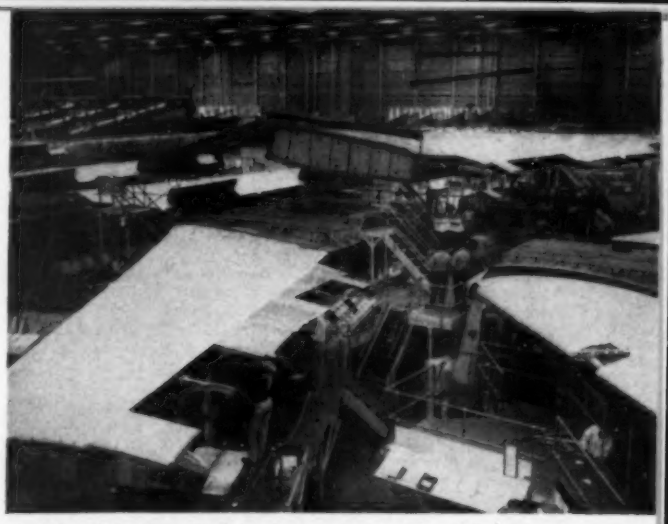
TRANSPORT BUILDERS' YEAR

LAST year's trading results for each of the three manufacturers primarily responsible for producing Britain's civil airliners could hardly be more varied, although each was undergoing conditions of severe transition. In each instance it is impossible to pinpoint the exact value of aeronautical (as against general industrial) production: in the case of Vickers it is probably about one-third, while Bristol and de Havilland are almost entirely engaged on various aeronautical pursuits.

Largest of the three is Vickers, Ltd., with sales last year amounting to £203m. In the previous year, when revenue stood at £163m, aircraft sales were valued at about £64m. During 1957 the volume of military sales must have fallen as the Valiant was phased out of production, and civil deliveries were on about the same level as the previous year, so it was unlikely that aircraft sales were much above £50m. Bristol's total revenue rose less rapidly from £51m to £56m, Britannia sales realizing £19m. It has never been de Havilland policy to publish revenue figures, but last year's turnover was probably between £40m and £50m.

In terms of profitability the most highly diversified company (Vickers) came off best with a net profit of £6.4m (over 3 per cent on revenue) while that most completely involved in aviation (D.H.) had the lowest return (between 1 and 1.5 per cent on revenue).

Vickers-Armstrongs (Aircraft), Ltd., reached a new Viscount production peak with completion of 100 aircraft, a further nine being on final flight trials at the year end (scheduled production for the year was 127 aircraft). Of these, 94 were delivered, bringing total deliveries to 258. The directors' report remarks that "a falling off in the rate of Viscount orders was to be expected as the order book approached the 400 mark, but it is hoped there will be a resurgence of interest when the very competitive V.810 enters service . . ." Tooling for the Vanguard was more than 80 per cent complete at the end of the year, and the shell of the first fuselage was completed in December. T.C.A. placed orders for 20 of these aircraft early in the year, bringing total orders to 40. The first flight should take place later this year, first deliveries commencing in spring 1960. B.O.A.C. declared its interest in the VC.10 during the year, but an order for 35 was signed only last January. Delivery of these aircraft is scheduled to start in 1963. The programme suggests that, for Vickers' aircraft division, 1959 may be a lean year unless Viscount hopes materialize.

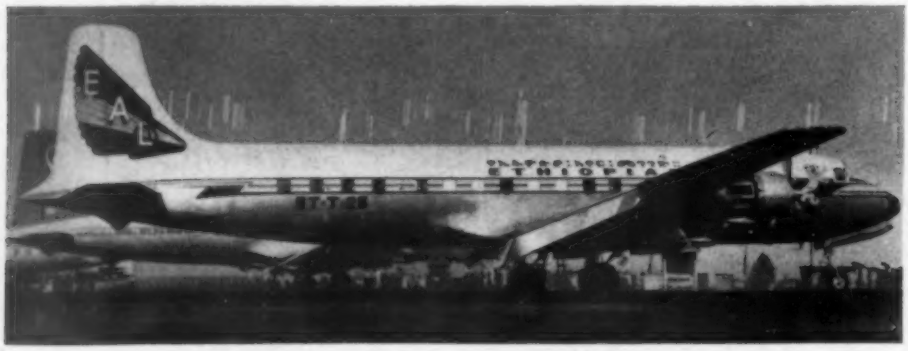


The wing of the first 707-320—the long-range version of Boeing's jet transport—is seen here being joined to the centre-section at Renton. The first 707-320, which is for PanAm, will be number 12 off the production line. Two 707-120s are now undergoing C.A.A. testing.

The Britannia accounted for one-third of Bristol sales last year. Orders on hand at the year end amounted to £125m, of which the Britannia represented £61m (export customers £16m, home customers £45m). Having noted that "the order book is shorter than we would wish," the chairman, Sir Reginald Verdon Smith, expressed his Board's opinion that "aircraft with low operating costs, and especially those powered with turboprop engines, are penalized because all fares are set at levels selected by reference to less economical equipment. If the highest speed obtainable below the speed of sound is not required by a passenger he should, in our judgment, be able to travel at lower fares in slower aircraft." Turning his attention to the Bristol 200, the chairman stated that "no decision to go ahead will be taken unless we can see that production orders on the scale required are reasonably assured."

Explaining the sharp drop in profits experienced by de Havilland in 1956-1957, Mr. W. E. Nixon, chairman and managing director, pointed out that "last year was a period of change during which, broadly speaking, we completed deliveries of existing types but did not gain any appreciable benefit from our expenditure on new products as deliveries had not started to flow." Mr. Nixon told shareholders that Comet deliveries would not start until the end of this year, adding that "the results of these efforts will not start to give any appreciable return until our financial year 1958-59." The financial strain of embarking on a civil airliner venture is shown by the company's decision to resort to the unusual practice of carrying forward £1½m expenditure on jigs and tools (this amount has been included in the value of work-in-progress shown on the balance sheet).

Contrasting strongly with the Bristol chairman's comments on fare structure are those of Mr. Nixon: "Air transport fares, which are severely controlled, have increased relatively little during the past ten years. The average profits of airlines are marginal and quite incompatible with either the greatly increasing turnover or the total capital investments." This certainly sounds like a plea for higher fares. But a view shared by all three aircraft manufacturers is that some device must be found to assist financing of airliner sales. Indeed, the Vickers report states quite bluntly that "a situation is rapidly being reached in which financing terms have almost as much influence on the placing of an order as the merits of the aircraft involved."



Due to be inaugurated tomorrow, May 24, is a new Ethiopian Airlines service from Addis Ababa to Cairo and Athens. Here is one of the airline's three new DC-6Bs, recently delivered by Douglas to Ethiopia.

In charge of B.O.A.C.'s new campaign to increase cargo business is Mr. W. D. Koster, who has just been appointed cargo manager.

The Foreign Secretary, Mr. Selwyn Lloyd, flew to the NATO conference in Copenhagen in a Hunting-Clan Viscount. He is seen (right) disembarking at Copenhagen.

CIVIL AVIATION . . .

TERMINAL PHILOSOPHY

ALL over the world millions of pounds of taxpayers' money are being poured into the construction of better, safer and larger airports. In layout, size and design most terminal buildings are proving hopelessly out of step with the fast-growing traffic, so new ones are being conceived, in a sweep of buoyant imagination to fit them to the shape of things to come.

But [writes a correspondent] can anyone at present predict with reasonable accuracy the pattern of air transport for the next decade? Pronouncements and forecasts uttered as recently as 1946 are already far off the mark. Is it not self-delusion to believe that air transport has today reached a stage of development permitting confidence in long-range planning of its facilities?

Whilst still far from mass travel, we are well on the way to it, and a great many changes can yet be expected in the type and volume of long-range operations. Furthermore, the increase of short- and medium-haul traffic is likely to gain momentum as fares become more acceptable; and if the helicopter takes its right place in the traffic pattern, the short-haul, inter-city traffic will transfer itself to this type of operation, and a substantial proportion of the traffic at present handled by airports and terminals will be absorbed by heliports.

Majestic buildings rise from the drawing-boards of contemporary airport planners. But such permanent structures are no mere castles in the air; inevitably they tie down the almost unpredictable future patterns of operation to the existing forms. Architects must, of necessity, either ignore the possible changes in equipment, traffic flows and volumes, or else fall back on supersize to avoid miscalculation and at best, make "planned" provisions for possible changes.

A more rational approach, it seems, would be to plan terminal buildings to give maximum service for existing traffic, and that forseeable within five to ten years, thus avoiding heavy capital investments warranted only when long-term depreciation can be expected. Realistically, this would mean light, inexpensive (possibly prefabricated) structures, with easily dismountable interiors. Interior walls, partitions, stands, desks, benches, etc., could be constructed in standard units which could be joined or transferred as and when required.

Criteria for a good terminal building can be summed up under a few headings: (1) functional layout adequate for all services, (2) aesthetic and harmonious interiors, (3) facilities for handling ingoing and outgoing traffic in speed, comfort and safety, (4) provision of auxiliary services and amenities.

All this can be attained with temporary and flexible set-ups. They need not be ugly sprawling hut-like buildings; the hand of a clever designer has transformed even barracks into objects of harmony and beauty. If an architect can create beauty only with heavy masonry and marble then he is not the right man for a job requiring functional flexibility in the extreme.

It is pertinent to remark that the amenities generally provided by terminal buildings do not keep pace with the standard of those offered by airlines. Perhaps there is a parallel situation in the frequent discrepancy between the standards of express train services and the dreariness of most railway stations. Whilst a terminating passenger is impatient to get to his final destination, a transient traveller should have the opportunity of shopping, taking showers, and using barber-shops, beauty parlours, changing rooms, valet services, etc. These and other amenities can be provided at a relatively low cost and represent an additional source of revenue for the airport.

At most airports, revenue from air traffic is not sufficient to cover the cost of operation. In the United States the provision of amenities designed to augment the airport's income is widely practised. We may, of course, shy at the American commercialized approach which makes airport managements use aggressive merchandising policies and sales techniques and devices, be they turkey or tomato farms, baseball fields and swimming pools, night clubs and skeet (clay-pigeon) ranges, midget auto race tracks and laundries. But the cold fact remains that revenue-producing non-aeronautical concessions can help to cover the deficit which otherwise falls to the burden of the suffering taxpayer.

BREVITIES

A SCOTTISH AVIATION Twin Pioneer is due to leave Prestwick today for a Middle East demonstration tour, during which it will visit the Lebanon, Jordan, the Sudan, North Africa and Southern Italy. Twin Pioneer G-AOEN is making short demonstration tours of Central America after completing its C. of A. overhaul in Mexico.

* * *

A correspondent in Holland reports that the two Fokker Friendships ordered by K.L.M. may not now be taken up by the airline.

* * *

It is reported from America that 90 aircraft is the break-even figure for the Convair 880. The number on order at present is 63.

* * *

Reports of 2,000 near-misses between aircraft have reached the C.A.B. during the last two years. Six of these have been investigated directly by the Board.

* * *

Master Air Pilot Certificates have been awarded by G.A.P.A.N. to Capt. C. H. Gray of Trans-Australia Airlines, and to Mr. B. F. Russell, C.F.I. at the College of Aeronautics, Cranfield.

* * *

On May 12 a B.O.A.C. Comet 2E, in the course of transatlantic proving flights, flew from Gander to London in 4 hr 33 min, a distance of 2,400 miles.

* * *

The contract for the development of Nandi airport, Fiji, has been awarded by the New Zealand Government to the British firm of Taylor Woodrow (Overseas), Ltd. This will involve extensions of runways, aprons and taxi tracks. Work begins in June, and is due to be completed in December 1959.

America's *Aviation Daily* reports that S.A.S. were recently fined $20,000 for their "breach" of the sandwich agreement.

* * *

It is reported from Italy that Alitalia's four DC-8s will be equipped with Rolls-Royce Conways.

* * *

The Congress of the Institute of Transport will be held in Dublin between June 3 and June 6.

* * *

The first Smith-Super 46C (modified 56-seat C-46) has been delivered by the L. B. Smith Corporation to Transair, Sweden.

* * *

Capt. A. V. Donati has been appointed chairman and managing director of Orion Airways, Ltd., of Blackbushe, in succession to Capt. P. E. Palmer.

* * *

Reports from Australia indicate that Commonwealth Aircraft Corporation of Melbourne have submitted to the Australian Government a design for a DC-3 replacement.

* * *

B.E.A. and Lufthansa have concluded an air cargo pooling agreement on services between London and Dusseldorf, Frankfurt and Stuttgart. Each week there are six B.E.A. DC-3 - Pionair flights, and five Lufthansa Viking flights.

* * *

New Zealand National Airways Corporation's first Viscount 807 carried 7,756 passengers between Christchurch and Auckland in its first eight weeks of operation, at a load-factor of 75 per cent. This is a 40 per cent increase over the traffic carried last year. The two remaining Viscount 807s will be delivered early next year.

Over 50 gang-mower units leaving the Ipswich factory of Ransomes Sims and Jefferies to supplement the already large teams of such equipment used by Jack Branch, of Cambridge, for airfield-mowing under contract in various parts of the country.

THE INDUSTRY

Financial Results

THE parent companies of four British manufacturers—de Havilland Holdings, Ltd., The Bristol Aeroplane Company, Ltd., Rolls-Royce, Ltd., and Vickers, Ltd.—have just published their latest annual accounts. De Havilland net profit for the year ended September 30, 1957, was £619,611 (1956, £1,659,238) after taxation (£959,266 in 1957; £2,190,767 in 1956). Last year's profit was shown after certain expenditure on Comet jigs and tools amounting to £1,276,783 (1956, nil) was carried forward against future sales contracts.

Bristol's net profit for the year ended December 31, 1957, was slightly lower at £806,296 (1956, £1,065,028) after taxation (£807,369 in 1957, £781,949 in 1956). Revenue increased to £56m (£51m in 1956) of which 34 per cent represented Britannia sales.

Rolls-Royce sales for the year ended December 31, 1957, rose sharply from £81m to £92m, but an increase in expenditure (particularly on research and development: £3.0m in 1956, £4.3m in 1957) saw net profit after taxation rise only slightly from £2.1m to £2.3m (taxation fell from £3.2m in 1956 to £3.1m in 1957).

Accounts for Vickers, Ltd., show an increase in net profit from £6.2m to £6.4m. About one-third of the group's total revenue (£203m) is attributed to aircraft sales.

Titanine Progress

A NET profit of £116,999 (before making provision for taxation) was announced by Titanine, Ltd., at their recent annual general meeting. This compares with £94,287 for the previous year, and taxation will absorb £66,263 of the current net profit figure.

The chairman, Admiral Sir Lionel Preston, said that sales of the company's materials for the protection of aircraft reached a record level during 1957; but some reduction was bound to be experienced this year because of the Government's cancellation of military orders. Fortunately a large proportion of Titanine finishes were used by manufacturers of passenger aircraft, for which there should be a big future.

Admiral Preston reported that the new synthetic resin factory at Welwyn Garden City was nearing completion and said that production should start there in the early summer.

Forklift Trolley Attachment

A FORKLIFT attachment for their Miniveyor power trolley has been announced by Whades (Sussex), Ltd., Duke Street, Littlehampton, Sussex. It costs only £48 over and above the Miniveyor's basic price of £98 18s and is thus claimed to be the lowest-priced mobile forklift currently on the market.

The attachment can be fitted to the Miniveyor by one man in a minute and removed in a few seconds. It is actuated by a hydraulic fork and ram and is capable of lifting loads of up to 4 cwt to a height of 4ft.

The Hunter's Fuel System

OUR review of the Hawker Hunter (May 9) included a description of the fuel system, in which several references were made to various components as named by the makers of the aircraft. In this connection another important name should be added—that of Flight Refuelling, Ltd., who state that in approximately 50 per cent of Hunters the refuelling adaptor located in the port wheel bay is of their manufacture. They add that other items in the fuel system which they manufacture are pipe connectors; high- and low-level float switches of a number of types, including a dual pattern; refuelling indicators in the cockpit; and Mk 17 pressure refuelling valves, of which there are six in each aircraft.

IN BRIEF

Zwicky, Ltd., of Slough, Bucks, announce that W/C. H. P. Matthews, O.B.E., B.E.M., has been appointed managing director.

* * *

Ferranti, Ltd., report that Mr. Sebastian Z. de Ferranti has been appointed managing director as from May 9. Sir Vincent de Ferranti remains chairman of the company.

* * *

The design organization at Airmed, Ltd., South Road, Temple Fields, Harlow, Essex, has recently been approved by the A.R.B. for the design of oxygen masks and associated equipment.

* * *

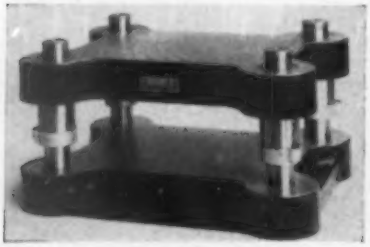
Mr. E. E. Pheasey, M.B.E., M.I.B.E., has been appointed works director of Thompson Bros. (Bilston), Ltd., Bradley Engineering Works, Bilston, Staffs. He was formerly with Foster, Yates and Thom of Blackburn, Lancs.

* * *

Mr. L. W. Anderson, until recently chief project engineer with Miles Structural Plastics, Ltd., has now been appointed chief project engineer of Wemyss Woodhouse, Ltd. He will be responsible for technical management of contracts and developments at their new factory—at Tolpits Lane, Watford, Herts—designed for reinforced-plastics manufacture.

* * *

Racal Engineering, Ltd., Western Road, Bracknell, Berks, are now acting as sole U.K. agents for the sale of transitron equipment manufactured by Van Norman Industries, Inc., of Manchester, New Hampshire, U.S.A. Technical details and prices of the equipment—which includes V.H.F. and U.H.F. signal generators and sweep generators of advanced design—can be obtained from Racal Engineering.



The latest addition to the Desoutter range of pillar die-sets is this extra-rigid model. The Hendon firm also announce six new drills in their range of lightweight pneumatic portable tools; over 50 per cent noise-reduction is claimed.

Mr. J. K. Brown (left), until recently public relations manager of the de Havilland Engine Co., has been appointed Middle East regional manager for the D.H. group; Mr. J. E. Scott (centre) succeeds him at Leavesden, and will be assisted by Mr. K. T. Fulton (right).

* * *

Offices at 60 Trafalgar Square, London, S.W.1, now accommodate the London technical staff of the following companies of the Serck Group: Serck Radiators, Ltd.; Serck Tubes, Ltd.; Audley Engineering Co., Ltd.

* * *

Mr. A. H. Waine, a director of Hadfields, Ltd., and managing director of its subsidiary Hadfields Forgings, Ltd., died suddenly in Brussels on May 4 while on a business tour of Belgium, Germany and Holland. He was 57, and had been with Hadfields, Ltd., for over 40 years.

* * *

We also regret to learn of the death, on May 3, of Mr. Frederick Barber, managing director of the Walter Kidde Co., Ltd.

* * *

We regret, too, to record the death of Mr. S. B. Smith, who retired in 1956 after 44 years with Marconi's Wireless Telegraph Co., Ltd. He was an expert in D/F. technology, in which he made his first experiments during World War I.

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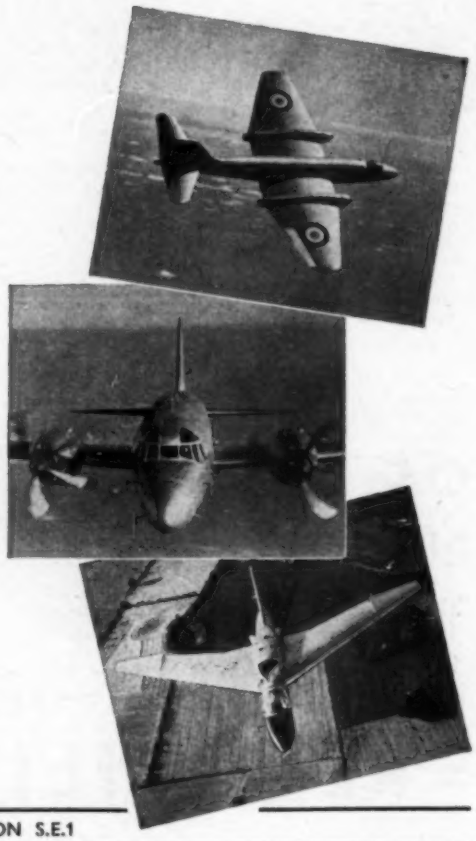

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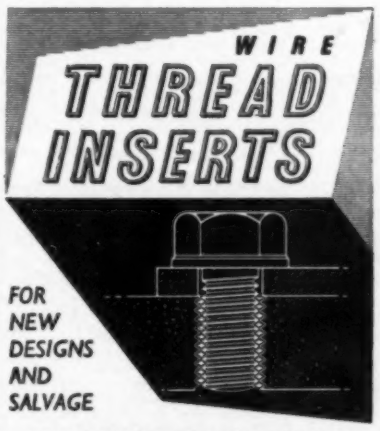

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THIS application will be considered by the Council under the Terms of Reference issued to them by the Minister of Civil Aviation on 30th July, 1952. Any representations or objections with regard to this application must be made in writing stating the reasons and must reach the Council within 14 days of the date of this advertisement, addressed to the Secretary, Air Transport Advisory Council, 3 Dean's Yard, London, S.W.1, from whom further details of the application may be obtained. When an objection is made to an application by another air transport company on the grounds that they are applying to operate the route or part of route in question, their application, if not already submitted to the Council, should reach them within the period allowed for the making of representations or objections. [7917

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Director, Naval Education Service (P/136),

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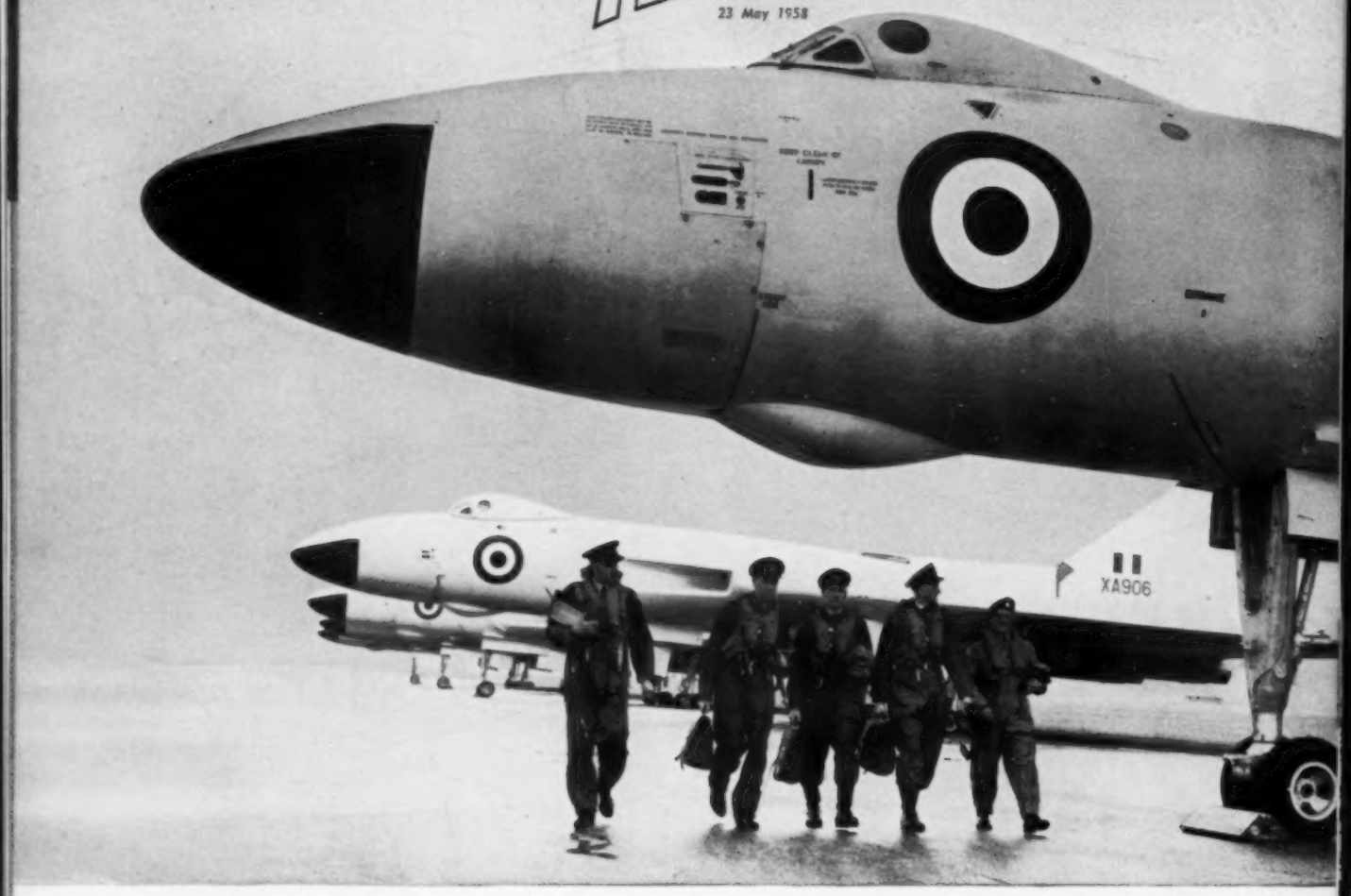

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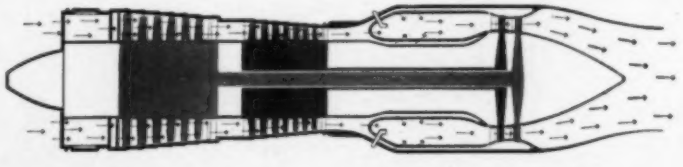

Gas-flow diagram of Bristol Olympus, illustrating twin-spool principle: low-pressure system in grey, high-pressure system in black.

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